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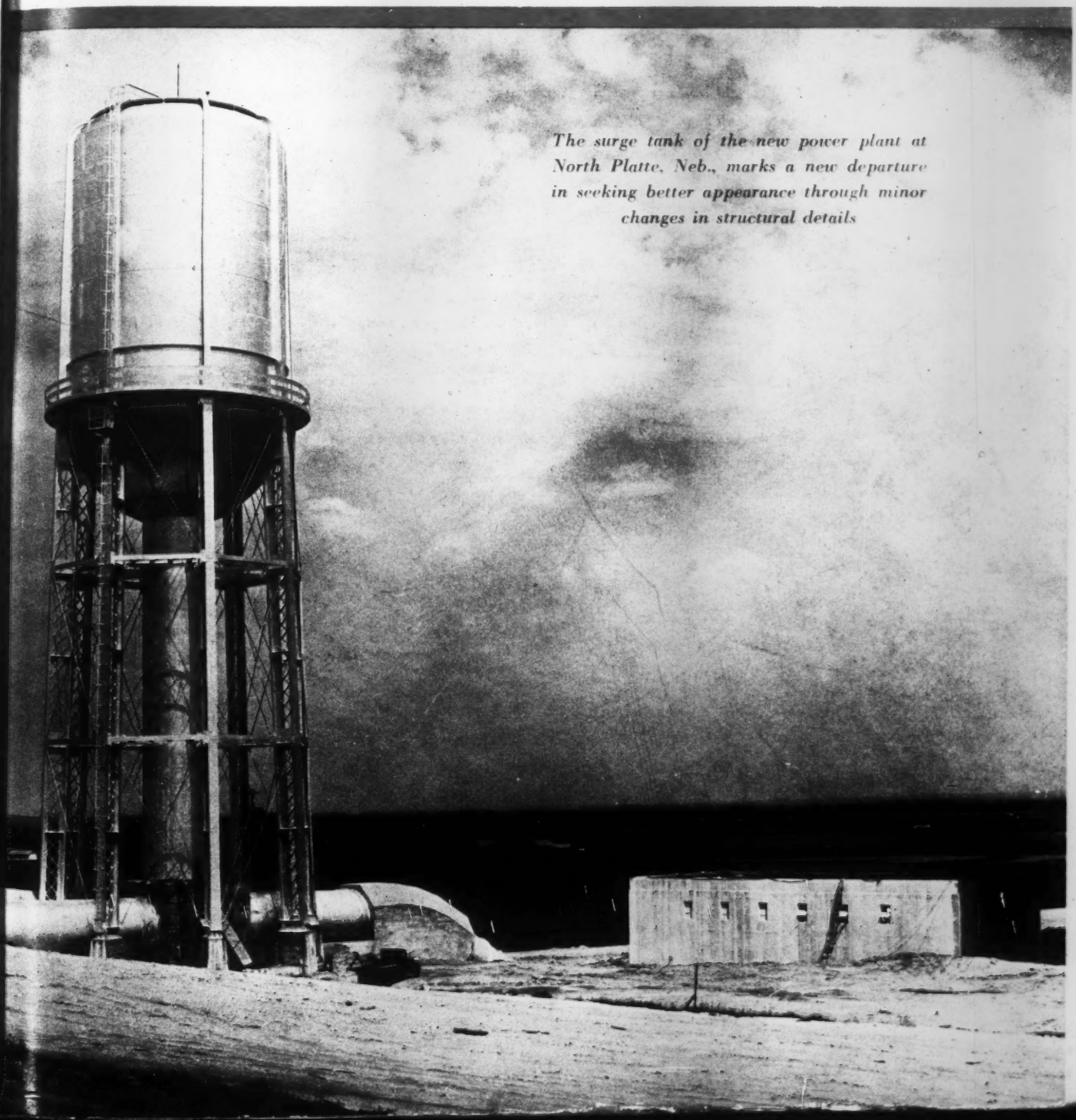

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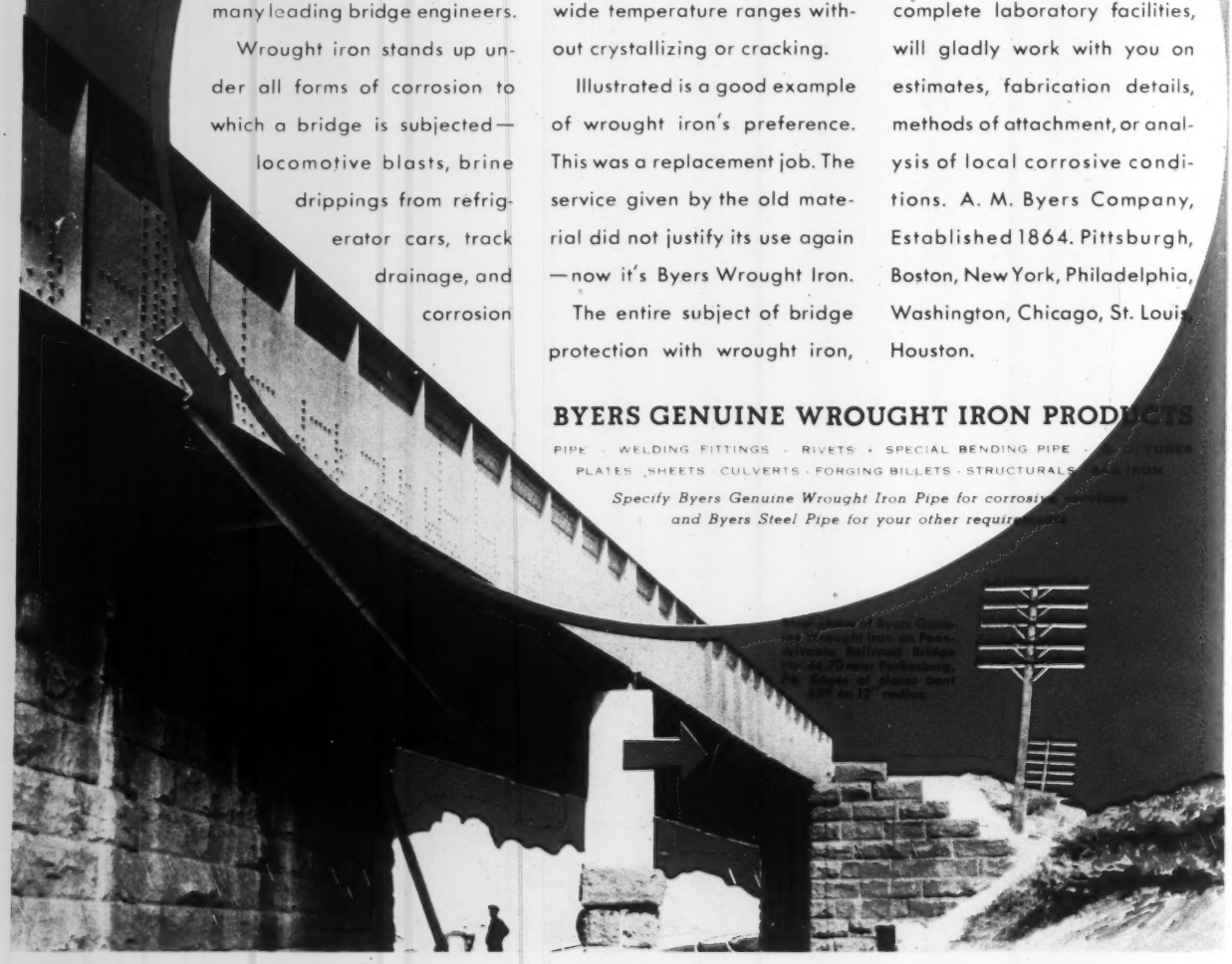

IN BEHALF *of the* DAY'S WORK

NOT long ago a sales manager of the old school asked one of his young men about to leave on a sales trip what he was looking up in a time-table. "I'm checking on what train I can catch to get me home by Thursday," he replied.

"Can you imagine it?" exploded the manager, "Before he tackles the job, before he even has a chance to size it up, he is planning to get home. He is more worried about when he gets home than he is about the job he has to do. Either the youngsters are pretty soft today or else they are being coddled to a fare-you-well."

One need not be unduly hard-boiled to sympathize with this outburst. It is a fact that many have come to regard the day's work as a penance. To such the job is but a source of the wherewithal required to do the things they really want to do. All this is a pity, especially when we remember how much of our lives we must spend at our work and how real are the satisfactions that can be derived from work well done for its own sake.

TO be sure, there lingers in some quarters a vestige of the tradition that "the job's the thing." We find it in the trouper whose first commandment is that "the show must go on." The newspaper man has it; the railroad man has it; the lineman of the wire services has it; all these must do their bit at whatever hazard or personal sacrifice. In these and kindred callings toil the true "Sons of Martha."

Of course, in these days of exaggerated class consciousness all this must sound old-fashioned and stodgy. Pride in the job, the agitators tell us, is but a weapon used by calculating employers to enslave their workers. Devotion to the day's work is but stupid submission to exploitation. For these outmoded virtues they would substitute the principle of "put in what hours you must and do as little and get as much as you can."

Unfortunately, all this has two sides. Those who dismiss so cynically all sense of loyalty and devotion to the job can cite too many cases in which such virtues have been exploited. For love of their work, loyal men in many fields have worked themselves to death while manipulators skimmed the cream of their productivity. Selfless employees have poured their lives into their jobs with meager rewards, while financial "geniuses" syphoned off the earnings and then wrecked the enterprises in the bargain. To exalt the virtues of loyalty in the face of such conditions makes a measure of cynicism understandable.

BUT to offset such cases are the many employers who have taken it on the chin along with their employees. They have battled to maintain their businesses as useful and productive enterprises rather than financial rackets and they have shared fairly with their people the rewards and griefs of their common struggle. There are many more employers of this type than of the other; and it is literally true that they are eager to find and quick to appreciate the employee who tackles his day's work with some share of their own enthusiasm.

Today, with both employers and employees more and more sensitive to class rights and wrongs, it is worth while to keep alive the tradition of putting all we have into the job in hand. The rewards of devotion to the day's work are manifold and go beyond those included in the pay check. Let us do what we can to curb the exploitation of selfless loyalty and to insure fair rewards for wholehearted service. But meanwhile the fact remains that each of us will be the richer on many counts for taking a pride in the day's work. This is especially true in construction where a job well done is an enduring monument to all who labored on it.

All this is no new problem. Thousands of years ago it inspired a Solomon to write: "Seest thou a man diligent in his business? he shall stand before kings; he shall not stand before mean men."

Willard Chevalier

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ASSURANCE IN ADVANCE

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● Responsibility for a service so vital to health and safety as water supply necessitates more than mere reliance upon acceptance tests. The experience, ability and integrity of the manufacturer are of equal importance.

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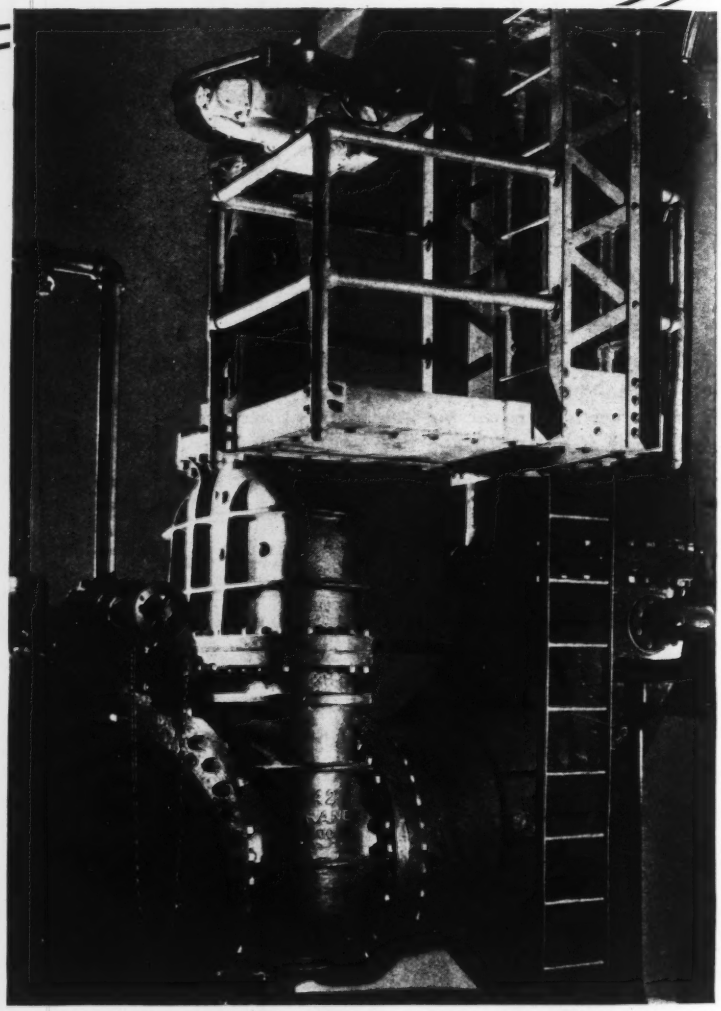

Crane 42-inch motor-operated valve on discharge side of 60-million gal. per day pump.

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New Life for an Old Dam— LAKE HODGES DAM in California developed cracks in its buttresses several years ago and has been under close observation since that time. Now it has been strengthened and given increased rigidity against earth movements. How it was reinforced will be described in an early issue.

Before and After pictures showing remarkable rehabilitation of Commercial Museum, 34th and Spruce Streets, Philadelphia, using stucco made with Atlas White portland cement. Plans and specifications prepared by the Department of City Architecture, Philadelphia.

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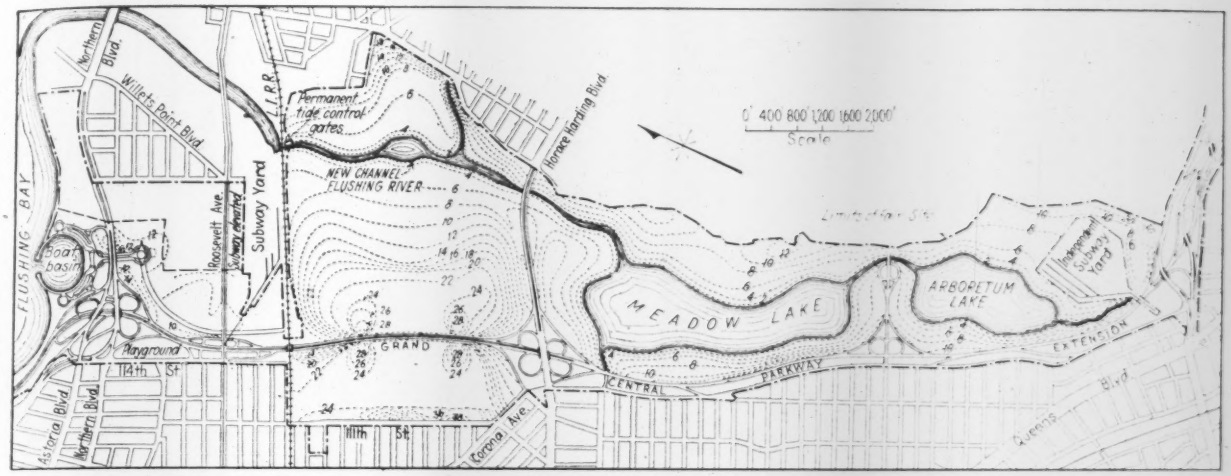


FAST GRADING OPERATIONS now under way will change 300 acres of ash dump and 800 acres of swamp into rolling topography, streams and lakes for permanent park to be used temporarily as fair site. This map shows the site as it will be at completion of current grading work, except some of the highways are yet to be built.

Ash Fill Converts Swamp Into Grounds for World's Fair

Mountain of ashes and rubbish supplies 6 million cu.yd. of fill to be spread over 780 acres of swamp for coming New York fair—Aquatic features of park require nearly a million cu.yd. wet excavation

FOR 35 years the ashes and rubbish collected in two of New York's boroughs—Brooklyn and Queens—have been deposited in an unsightly heap in a corner of a wide expanse of tidewater swamp land adjoining Flushing Bay in Queens. Today that mountain of waste material is being cut down and spread over the 780 acres of swamp as the first stage of development of the site for the New York World's Fair, to be held in 1939. Amid clouds of dust of its own creation a battery of shovels is attacking the mound of rubbish, loading into trucks that wheel unceasingly 24 hours a day over quaking swamp roads to the fill. Here the trucks pause but a moment to dump their loads, and then hurry back to the shovels. Bulldozers spread the dumped material to its final resting place. Another battery of draglines is scooping 800,000 yards of humus and muck from the swamp to create lagoons and stream channels as aquatic features of the fair grounds. Shovels and draglines move more than 40,000 cu.yd. every day.

The site chosen for the World's Fair is one of the largest undeveloped tracts in New York City, 1,110 acres of land known locally as Flushing Meadows, which barely rises above high tide level and through which meander the sluggish Flushing River and a few drainage channels. The site, though irregular in shape, in general is long and narrow, extending for 18,000 ft. southward from Flushing Bay, and varying in width from 500 ft. to 6,000 ft. It is crossed by the Flushing subway line (elevated), the Long Island R.R., by four existing highways, all to be reconstructed, and is tapped by numerous other roads and the future extension of the Independent subway system. An extension of the Grand Central Parkway, leading from the new Triborough Bridge, cuts through the western and southern parts of the tract, and connects with other parkways at elaborate separated intersections.

Within the site limits, the existing stream and drainage channels will be filled up and a new channel cut for the river. The river will flow through two large lakes now being excavated in the grounds, one 4,500 ft. long, the other 2,500 ft. long. A dam with tide-control gates will be built to maintain the lake waters at a constant level. At the north end of the grounds a boat basin will be built to accommodate water traffic from East River and Long Island Sound.

At the west side of the meadows, south of the railroad, a 330 acre tract was used as the ash dump. In three and a half decades the unsightly accumulation had piled up 90 ft. high in spots, and to an average elevation of 50 ft. Borings showed that the rubbish had settled 25 ft. into the swamp muck.

In the World's Fair plans the old ash heap, long an eyesore and a municipal disgrace, suddenly became a blessing, for here was the material that would transform the meadow site from swamp to usable ground. In fact, it is doubtful whether the site would have been economically feasible without the huge supply of dry fill immediately available. Hydraulic filling from the bay was undesirable, for engineering studies showed a wet fill over the swamp muck would have been unstable, so much so that the

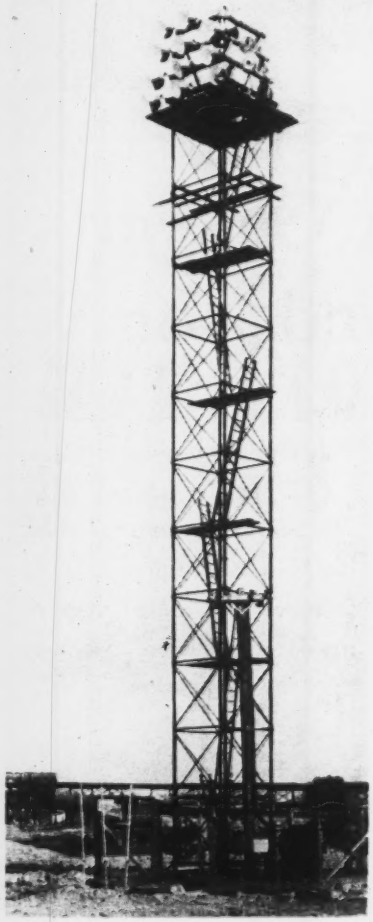
THE SHADES OF NIGHT are dispelled by powerful floodlights and excavation of New York ash heap continues 24 hrs. a day for grading of World's Fair site.

contractor is not even allowed to dredge out the comparatively small lake areas by hydraulic methods. Dry fill is scarce in New York, especially in quantities required for the fair grounds, and any other source of fill material would have raised the cost of ground preparation to prohibitive limits.

Therefore, the entire grading plan of the ground was based on the amount of material available in the ash dump. By careful planning, a rolling topography, much more pleasing than the existing flat meadow land, was laid out over the full site to exactly balance the cut and fill. The size of the lakes figured in the calculations, though all muck taken from lake and stream areas is being stored for later use as topsoil and consequently does not enter into the original grading calculations. One of the accompanying maps shows the site and its contours as it will appear at the end of the present grading contract, except that some of the roads shown are yet to be built.

The Flushing Meadow is a tidewater swamp covered by a 3-ft. mat of vegetation, mostly swamp grass and roots. Underneath the mat lies soft muck, averaging 70 ft. in depth over sand, clay and gravel. Experiments proved that the top mat would, in general, sustain 300 lb. per sq.ft. The ash refuse weighs about 2,000 lb. per cu.yd., and a fill of 4 ft. minimum thickness is considered ample to safely distribute all probable ground loading except buildings. The first layer of fill is made 4 ft. thick, and if no settlement or mud waves are apparent, the ground is built up to final elevations, sometimes as much as 14 ft. above sea level. No fill at present is placed within 50 ft. of shoreline of the lagoons. The ash dump is being graded down to conform to the general topography of the site, though several rounded hummocks 30 ft. high will be left in this area. The cut averages 40 ft.; the fill 7 ft.

At first consideration, the grading job might seem like an ordinary earth-moving proposition—simply cut, haul and fill. However, it is far from a simple job. It is not only the largest dirt moving job ever undertaken in the East outside of canal dredging, but it is one that requires the highest degree of construction planning and management. Consider the problem: 6,200,000 cu.yd. of dry material to be dug out of an uneven pile, hauled an average of 4,000 ft. and spread over a swamp without producing settlement or mud waves, and 800,000 cu.yd. of muck to be dredged by dragline or clamshell from the swamp and stored for future use as top surfacing, all to be done in the short time of 42 weeks.

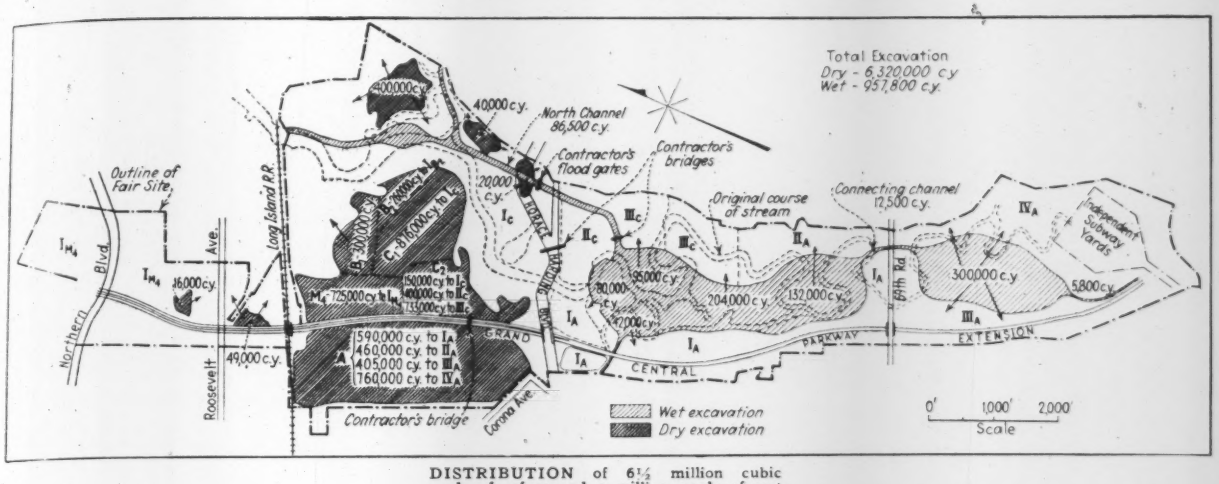


RACKED CLUSTERS OF LIGHTS atop twelve steel towers, each 80 ft. high, turn night into day for grading work

The contractor had to take full responsibility for mud waves, and any ground heaving or displacement must be corrected at his expense. All old stream channels outside of the lake areas must be filled with dry material. This requirement, coupled with the necessity of storing on completed fill all dredged wet material for future topsoil, complicates the filling process. Naturally the new channels must be completed before the old channels are filled. To complete sufficient filled ground near the dredged areas to accommodate the wet muck storage, and still clear the old channels is a problem. The muck cannot be piled up very high, as it is impossible to haul over it or to work it with bulldozers. The providing of access roads to the fill, over swamp land and streams, and across busy highways, some carrying street car tracks, was another problem.

Realizing that there were plenty of chances to go wrong, and that a false move would prove disastrous to a fast schedule, the contractor carefully planned the job before bids were submitted. A map was prepared showing the cuts and fills and their yardages, and a schedule drawn up to show the exact movement of dirt from excavation to fill (see accompanying drawing). This schedule has been followed closely, and progress is exactly as anticipated.

For the dry excavation the contractor chose 1½-yd. gas shovels equipped with 2¾-yd. buckets, a combination possible because of the light weight of the material being handled. Gas draglines with 1½-yd. buckets were selected for wet work, and gas tractor bulldozers for spreading the fill at the dumps. Trucks and truck-trailer units do the hauling. To maintain the required schedule, the job was equipped with the following major equipment: eight 2¾-yd. shovels, five 1½-yd. draglines, twenty 13-yd. bot-



DISTRIBUTION of 6½ million cubic yards of refuse and a million yards of wet excavation. This chart was prepared by the contractor prior to start of work as a general grading plan.

tom-dump truck-trailer units, 76 dump trucks from 7 to 8 yd. capacity, fourteen bulldozers and three truck cranes. Six shovels, all draglines, all truck-trailer units and sixteen trucks were purchased new, the remainder of the haulage equipment is obtained from local sources.

Digging plans called for benching of the ash heap in 10-ft. cuts, and preparations for excavation were simple. Access roads were cut out to upper levels of the rubbish dump, where excavation started. The ash dump is solid and even the newly cut benches support trucks and shovels without mats or other road surfacing.

However, preparations for hauling and deposition of the fill were elaborate. First, main routes from sections of the borrow pit to central fill areas were established. Substantial temporary bridges and overpasses were installed where these routes cross streams and highways. A bituminous macadam road, 22 ft. wide and 5,500 ft. long, was built along the edge of the swamp as a main feeder route. In unfilled areas trucks serving the dragline cut areas operate over plank roads of 6x10-in. bolted timbers. The draglines operate on timber mats 5 ft. wide made up of 14x14-in. sticks 36 ft. long, bolted together. A temporary tide gate structure has been installed to maintain the lagoons and streams at constant level.

Grading operations

The eight shovels are arranged in three or more groups, the number, size and location of the groups varying from time to time as excavation and fill conditions change, but always in accordance with the general plan and schedule. The five draglines are spotted individually around the meadow cut areas. Sixteen trucks of one size and make are assigned to the draglines, the other 60 and the truck-trailers work with the shovels. In general, an attempt is made to assign haulage units of comparable capacity and speed to each shovel in order to maintain a steady output for each excavating unit. The shift superintendent assigns the trucks to definite shovels and to definite dumps. Occasionally changes are made during the shift, but usually the assignment stands for the full shift, and often for days at a time. Naturally, a careful watch is kept to see that neither shovels nor trucks stand idle. The arrangements of shovels and haulage units must be kept in close balance to maintain the schedule.

Each dump is in charge of a foreman, and trucks are waved to desired discharge points by spotters. Little time is lost in dumping; the trailer units never stop, and the dump trucks discharge only in the general vicinity of the final position of the material. It is necessary to bulldoze the material to place because it is not safe to run the loaded trucks within 50 feet of the face of the fill.

Progress

Phenomenal progress is being made. Work is carried on in three 7½-hr. shifts per day, five days a week. Daily excavation runs from 40,000 to 50,000 cu.yd.; about 1,000,000 cu.yd. monthly. So far, adverse weather has affected progress but little, in fact rain helps by keeping down the dust. A hard rain softens the dumps for a short while, but not sufficiently to cause trouble. The ashes, though easy to dig, pack well in the fill under the action of trucks and tractors, and tend to shed water rather than absorb it.

Looking forward to winter, the contractor believes freezing will help progress, for the ashes will freeze only slightly, and much dust will be eliminated. One troublesome feature is the presence of metal rubbish in the ashes, including old automobile frames, pipe, plumbing fixtures and hundreds of domestic hot water tanks. All such material must be disposed of off the site. Another source of trouble has been deep-burning fires uncovered in the ash heap.

The contract was awarded last June 15, and must be completed by April 1. A penalty of $2,000 a day is included in the contract. The contractor expects to complete the work late in February.

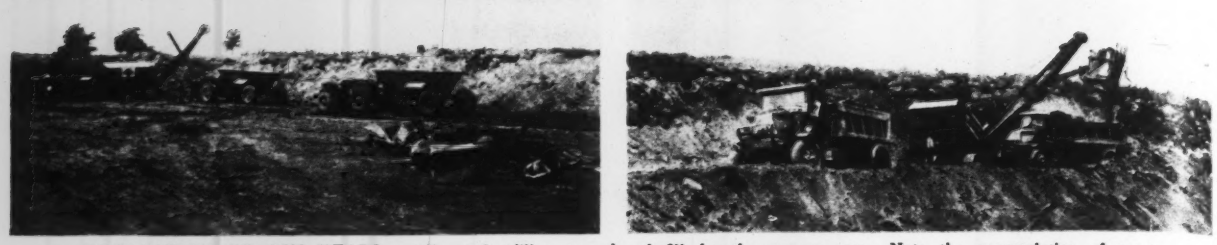
Equipment service

Adequate service for the array of excavation and haulage equipment is of great importance, for breakdowns and delays mean serious interruption to progress. Every piece of equipment on the job is gas operated, which simplifies the fuel problem. Gasoline is delivered by tank trucks to underground storage tanks at job headquarters. Two trucks, carrying 500 gal. each, one equipped with hand pumps, the other with a motor-driven pump, serve the units in the field, obtaining the gas from the storage tanks. The gas service trucks stop at convenient points on the roads from borrow pits to fill, where the trucks can be gassed quickly. These same gas trucks fuel the shovels, usually in the half hour period between shifts. They also carry oil and grease for the equipment. Oil in the trucks is changed daily, and is recovered through centrifugal cleaning machines. Several tire changing stations have been set up in the field. Two gas-driven portable compressors furnish air for tires and for operating air grease guns for servicing the equipment.

All equipment repair work is done at the job shop. The two-day layoff every week offers ample opportunity to keep the equipment in full repair, and breakdowns seldom occur despite the severe operating conditions. The fine ash dust constantly blankets the job, and naturally gets into all mechanisms of the plant units.

Lighting system

Because night production must equal that of daylight hours, much attention was paid the installation of a flood-lighting system, probably the greatest ever set up for a construction project. Competitive manufacturers were invited to submit lighting equipment for tests, conducted by a local power company. Tests included photometer readings on a 20x20-ft. target 1,600 ft. from the source of light.



EXCAVATION OF ASH HEAPS supplies 6¼ million cu. yd. of fill for the swamp area. Note the accumulation of scrap metal, a troublesome item in the digging.

DREDGING OF AQUATIC FEATURES of the park and fair site is by draglines, working on heavy timber mats over a thin crust of vegetation covering 70 ft. of muck.

FILLING IN THE SWAMP. Above is a 13-yard haulage unit rolling over a temporary bridge built by the contractor. Below are a couple of trucks at the dump, with a bulldozer in the background ready to spread the spoil. The fill, though resting on muck, is remarkably stable.

The main floodlighting system consists of twelve steel pipe towers, each 80 ft. high, erected at points to cover most of the cut and fill areas. Each tower carries from sixteen to 49 units, each unit a 1,500-watt clear lamp. The lamps are mounted in a sheet steel reflector 25⅜ in. in diameter, coated inside with white porcelain enamel and backed up with a special reflector. There are a total of 345 units, aggregating 500 kw. in power. The floodlighting system is for general illumination only. Each shovel and dragline is equipped with its own lighting unit, and of course the truck lights illuminate the roadways. Several portable gas-electric lighting units are available for dark corners and for emergency repair work.

The fair is being financed by private underwriting and by state and city appropriations. All of the grading work is being done by the New York City Department of Parks, for the site will become a permanent city park when the fair is over. The fair corporation has leased the prepared site from the city.

The grading contract is held by The Arthur A. Johnson Corp. and Necaro Co., Inc., both of New York, who combined to bid $2,186,185 for the work. They were third low bidder, and were awarded the work when the Commissioner of Parks ruled the two low bidders incapable of performing the work in schedule time. Construction management is under the personal supervision of A. D. Saunders, vice-president, and William Beattie, chief engineer, of The Arthur A. Johnson Corp., representing the combined contracting companies.

Increased Property Values

INCREASED valuation of the land between 54th and 58th streets on Sixth Avenue, New York City, has come as a result of the demolition ten years ago of the elevated railway structure, according to a WPA study under the direction of Edward M. Law, assistant engineer for the Board of Transportation, to determine the probable effects of the removal of the entire Sixth Avenue elevated railway. The study is considered as being significant inasmuch as it seems to indicate that increased tax revenue resulting from the demolition of the present structure would in some measure offset the $416,861,000 required by the city for execution of the proposed transit unification program.

In making the survey plots were laid out in three 100-ft. zones. Land in the first 100-ft. zone was found to have increased in value from $5,398,000 in 1924 to $12,519,000 in 1934, and after correction for a computed normal increase, it was found that the net increase was $5,429,000, about 100 per cent. Land extending from 100 to 200 ft. back of the elevated structure showed, after correction for the normal rise, a net increase of about 34 per cent and land in the third zone was found to have increased about 24 per cent.

Precast Concrete Cylinders Support New Wharf

Unusual combination of caissons and piles used in re-building of harbor facilities at Saint John, N. B., in 28-ft. tide without cofferdams

SINCE 1785, when the first wharf was built, Saint John, N.B., has been one of the principal ports of Canada's Atlantic seaboard, and is especially important during winter months when ice closes the ports of Montreal and Quebec. Shipping facilities were developed jointly by the city, the Dominion government and the Canadian Pacific Ry. on both sides of Saint John Harbor. In 1927 the government purchased the city's interest in the harbor and established Saint John as a national port. On June 27, 1931, the whole of the West Side harbor facilities was destroyed by fire down to half tide level. The burned sheds and piers were rebuilt at once, with the exception of four wharves known as Berths 1, 2, 3, and 4, whose reconstruction was delayed by bad condition of the substructure. There is a 28-ft. tide at Saint John, which complicates all waterfront construction. In 1932 a new pier and a new quay, carrying three sheds and grain galleries, were built within a cofferdam enclosing 43 acres. This construction, which involved gravity concrete walls carried on concrete piers and arches, was described in *ENR*, Feb. 15, 1934, p. 219. In 1934 reconstruction of Berths 1, 2, 3, and 4 was started as the final step in restoration of the burned facilities. An unusual design was adopted, consisting of precast concrete cylinders as the main foundation, with piling as supplementary supports, all construction being carried on without the use of cofferdams, despite the high range of tides. The design and construction of these facilities were described by Victor S. Chesnut, senior engineer, Saint John Harbour Commission, in a paper presented at the Maritime professional meeting of the Engineering Institute of Canada on Aug. 28. The following is an abstract of the paper, with illustrations furnished by the author.— EDITOR.

FIG. 1—A FLOATING DERRICK rigged with shear legs sets the 9-ft. precast foundation cylinders. The longest caissons, 7-ft., weigh 132 tons.

AN UNUSUAL COMBINATION of precast concrete cylinders, 9 ft. in diameter and 55 to 70 ft. long, and timber piling is being used in the reconstruction of Berths 1, 2, 3 and 4 at Saint John Harbor, N. B., part of the extensive West Side harbor facilities destroyed by fire June 27, 1931. Improvements have been made in the arrangement of the berths, and now three berths or wharves are being built to replace the original four. The three, totaling 2,123 ft. in length, range along three sides of a five-sided docking area that extends out from the west shore of the harbor (see map Fig. 2). Included in the present work is a bulkhead wall 324 ft. long between new Berth 4 and existing Berth 5, and a retaining wall at the south end of Berth 1, both on pile foundations.

Originally the site of the present work was a tidal beach. From time to time various small wharves were built and the ground raised by filling. As deeper water become necessary to accommodate increasingly larger ships, the wharves were pushed out into the harbor, and the older structures covered with fill. All construction was timber, both cribbing and piling being used for foundations. The fire left the site a mess; tangled steel wreckage covered charred remains of cribbing and piling. Underneath were the old wharves, their skeletons covered with fill and burned wreckage. Obviously, reconstruction of the burned facilities was impossible without considerable foundation expense, for it would have been impossible to drive a pile through the old wreckage. Additional wharf facilities were being planned at the time of the fire, and the authorities decided to build them immediately and to delay reconstructing Berths 1, 2, 3 and 4 until more funds were available. The current and anticipated volume of shipping warranted start of reconstruction late in 1934.

Borings revealed that solid rock exists along the line of proposed wharves at various depths from El. -35 to El. -85. (El. 0 is mean low water; mean high tide is El. 28). Hardpan up to a maximum depth of 6 ft. covers the rock in places. A bottom of silt and clay of various depth and degrees of compaction covers the submerged parts of the site.

Wharf design

In view of the foundation conditions, it was decided to demolish and remove all of the old timber construction, and to provide new foundations to rock or to hardpan for a wharf deck 102 ft. wide along all three berths. Docking slips were to be dredged to El. -35 along Berth 1, and to El. -30 along the other two wharves.

Four types of foundation were considered for the substructure: (1) All timber construction, cribs to be used where the rock surface was high, and piles where it was low; (2) One row of concrete cylinders sunk to rock along the face line, with timber piles at the rear, supporting a concrete deck; (3) Two rows of concrete cylinders at the front, piles at the rear, supporting a concrete deck; (4) Three rows of concrete cylinders with timber piles under the rear wall only, with a concrete deck. The third type was adopted as being much more stable and permanent than the first two and costing but little more. Type 4 had many desirable features, but would have cost about $500,000 more.

The substructure of the wharf consists of transverse bents, 20 ft. c. to c. Each bent is made up of two precast concrete cylinders and two pile clusters. The cylinders, on the outboard end of the bent, are 9 ft. in diameter, sunk to rock with tops established at El. 15. Each of the two pile clusters contains 13 timber piles, surmounted by a 3½-ft. diameter concrete column with bell top and bottom. A 24-in. concrete wall ties the two cylinders, and 2x2-ft. concrete struts tie all cylinders and pile clusters together. A 3-ft. longitudinal face wall caps the outside row of cylinders. Covering the foundation structure is a reinforced concrete slab, 17 in. thick over the outside bay, 15 in. elsewhere. Its top surface is about El. 32.

At the rear of the floor slab is a gravity retaining wall, originally designed to be carried directly on piles. However, ground movement developed during the driving of these piles for Berth 4, and a timber relieving platform, 50 ft. wide, was built behind the wharf at El. 15, carried on batter piles and later back-filled. The rear wall was then built on the outside edge of this plat-

form. Fig. 4 shows a typical cross-section of the wharf structure. A rock and gravel toe fill and 3 ft. of riprap were placed in the dredged area under the wharf.

The bulkhead between Berths 4 and 5 is of interesting design. This structure consists of a timber relieving platform at El. 15, 63½ ft. wide, supporting a concrete retaining wall on the front (Fig. 3). Steel anchor rods tie the base of the wall back to a continuous concrete anchor wall. Steel sheet piling 66½ ft. long was driven along the face of the platform, the tops of which project into the base of the retaining wall. Trouble was experienced in the construction of the bulkhead, which will be described later.

A somewhat similar structure was required at the south end of Berth 1, to retain the fill under existing Berth 14. A timber relieving platform, 45½ ft. wide, carried on piling, supports a concrete gravity retaining wall built across the end of the berth.

The first move in the reconstruction of the berths was the award of a contract in August, 1934, for the demolition of the old crib work and the dredging of the site. This required the removal of considerable rock-filled cribbing and burned-off piling. The contract was on a cost-plus basis, and a large dipper dredge was loaned the contractor by the Marine Department of the government.

The first stage of operation consisted of demolition of the crib work from the top down to low water level. Locomotive cranes working from the land side and floating derricks tore the cribs apart and loaded the debris on scows. Most of the reclaimed timber as turned over to relief authorities to be cut up into firewood. After the site had been cleared to low water level, the dredge moved in to remove the submerged crib work and excavate the ground to required grade.

Dredging work was discontinued for the winter, and upon resumption of activities the following spring the form of contract was changed to a unit price basis. The dipper dredge was then replaced with a ladder dredge owned by the contractor. All of the remaining dredging and crib removal was done with floating plant.

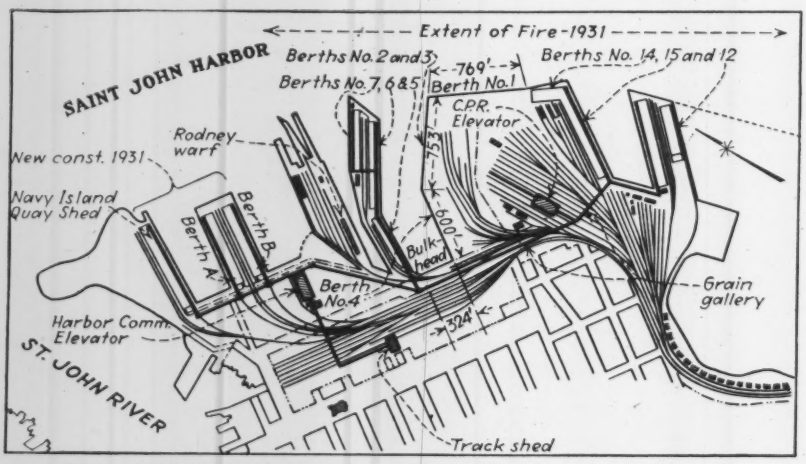
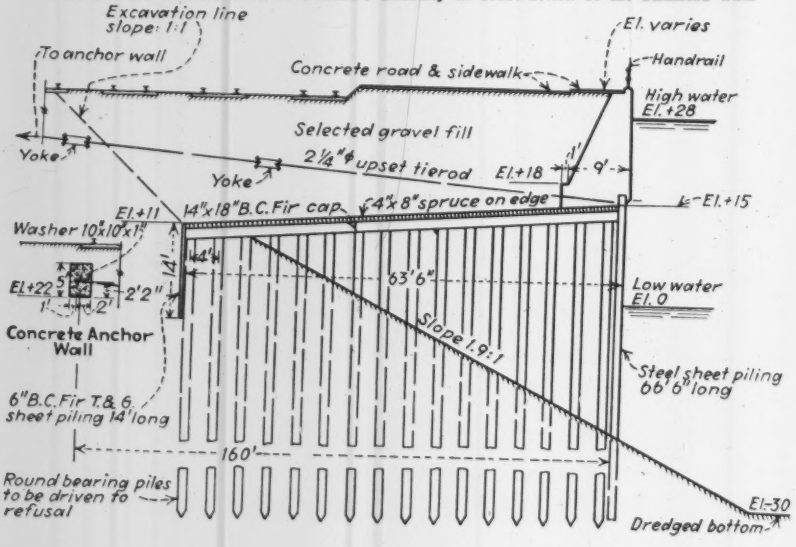


FIG. 2—RECONSTRUCTION of Berths 1 to 4 will complete restoration of extensive West Side harbor facilities at Saint John destroyed by fire in 1931.

FIG. 3—THE NEW BULKHEAD between Berths 4 and 5 is of interesting design. Ground movement caused considerable difficulty in construction of the bulkhead wall.



Cylinders cast in drydock

Arrangements were made by the contractor to cast the concrete cylinders in the government drydock at Courtenay Bay, not far from a beach source of aggregates. The cylinders are cast in groups in vertical position (Fig. 7) and are handled from drydock to storage and then to the job by a special floating crane fitted with 85-ft. shearlegs that project 40 ft. beyond the stern. The dock is flooded whenever a group of caissons is to be removed.

The cylinders, 9 ft. in outside diameter, with 12-in. heavily-reinforced walls, are cast in lengths from 55 ft. to 70 ft. A steel cutting edge for each caisson is placed on the drydock floor, on which is set steel forms 13½ ft. high. The core of each form section is blanked off at the top by a wooden platform, upon which the concrete is deposited for shoveling into the forms. From four to six forms are poured together. Experiments have shown that a concrete mix of 1½-in. slump works best. All concrete is puddled with internal vibrators.

Filling the forms is usually a day's pour. After the concrete has set sufficiently, all laitance is carefully removed and the forms are raised for the second lift of 13½ ft. This process is repeated until the top of cylinders is reached. The top lift is of variable height. Curing by water spray, both inside and outside of the shell, is continuous for 7 days. Cylinders may be removed from the dock 20 days after the final pour is made.

Concrete for the cylinders is supplied by a central plant set up near the rim of the drydock. Coarse aggregate is measured by a batch hopper, sand by an inundator. From the ½-yd. mixer concrete is discharged into 1-yd. bottom dump buckets carried on a flat car. A locomotive crane transfers the car to near the forms, and then handles the buckets to place.

Caisson sinking

In preparation for sinking of the cylinders a pile and timber falsework is built to carry a traveling derrick. The falsework is dismantled and carried forward as sinking of the caissons progresses. A separate timber enclosure is provided as a sinking guide for each cylinder. Just prior to sinking, the site of each caisson is carefully cleaned out to make sure there is no timber or other obstruction on the bottom.

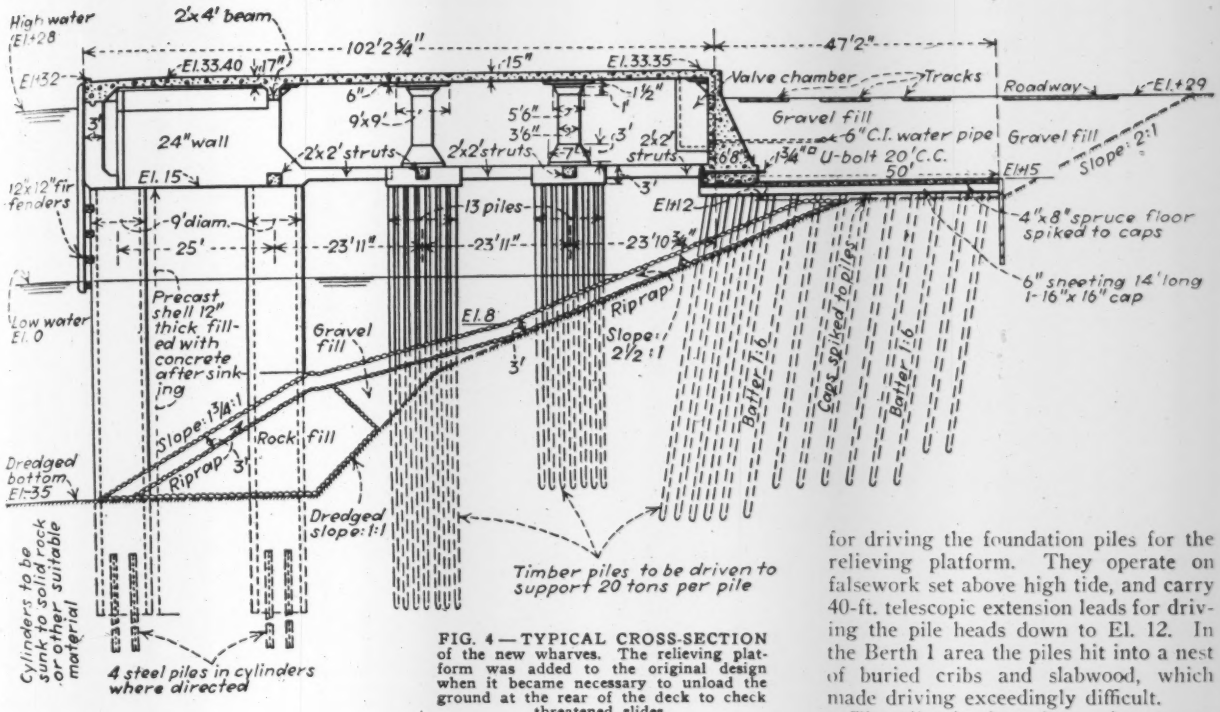


FIG. 4 — TYPICAL CROSS-SECTION of the new wharves. The relieving platform was added to the original design when it became necessary to unload the ground at the rear of the deck to check threatened slides.

The cylinders are brought from storage to the job one at a time. At the site they are hoisted to vertical position by the shear legs of the floating derrick, carefully checked for plumb and position, and are lowered slowly to the bottom within the timber guides (Fig. 1). If the bottom is soft, the caisson will sink several feet into the mud by its own weight.

Because of varying foundation conditions, the sinking of each cylinder is a separate problem. In general, sinking is by excavation from within the shell with a clamshell handled by the traveling derrick, though jetting and additional weighting are required in hard material. The necessary jetting is done by divers. Besides as an aid to excavation and sinking, jetting is sometimes used to correct the tendency of the cylinders to drift or shift out of plumb. Cast-iron blocks are placed on top of the cylinders when additional weight is needed. Occasionally as much as 50 tons extra weight is required to land the shells on rock. Boulders too large for bucket removal are broken up by blasting, this work being done by divers.

After the bottom is reported clean by a diver, filling of the cylinders with concrete is done at once. A steel shell, extending to about high tide level, is attached to the cylinder as a guide for concrete buckets. Concrete, mixed in a floating plant, and lowered to the bottom in buckets, is dumped very slowly to prevent wash. A rich mix is used for the seal up to 1 ft. above top of cutting edge. Filling is stopped at El. 7 to allow the laitance to collect, usually 8 in. to 12 in. deep. This is carefully removed before the cylinders are finished. The caissons are cast to shorter lengths than actually required to enable them to be brought to exact grade, El. 15, by building up at the site. The extensions to grade are made within a steel form during low-water periods.

Ground movement

Some twenty cylinders were sunk and filled last fall and winter. In March of this year pile driving was started on the pile clusters and on the rear wall support. Before long cracks were observed in the ground to the rear, and a check on the cylinders in place revealed that some of them had shifted. Pile driving was continued for another day, but when it was found the cylinders were still shifting, work was discontinued. A careful survey indicated that the caissons were tilting on their bases, but the bottoms were holding to position. Slight movement continued for two weeks, and the ground cracks widened, but no general slide developed.

After considerable study by the engineers and contractors, it was decided to unload the area at the rear of the wharf by excavating to El. 12 for 50 ft. beyond the rear wall line, and to build a timber relieving platform carried on battered piles. All pile driving was then to be kept in advance of cylinder sinking, and the dredged slope of ground through the wharf foundation area was flattened.

Excavation behind the wharf is by a dragline with a 100-ft. boom. Spoil is loaded into barges or on trucks, whichever is the more handy.

Two special skid drivers, with 60-ft. leads set on a 1 : 6 batter, were rigged up for driving the foundation piles for the relieving platform. They operate on falsework set above high tide, and carry 40-ft. telescopic extension leads for driving the pile heads down to El. 12. In the Berth 1 area the piles hit into a nest of buried cribs and slabwood, which made driving exceedingly difficult.

The piles in the column clusters are driven by a revolving rig carried on falsework (Fig. 6). These piles range in length from 30 to 80 ft., which is an indication of the variable ground conditions.

Low-tide operations

Building of the relieving platform, and all concrete construction above the tops of pile clusters and caissons, must be done at low tide periods, for twice a day the site is flooded to El. 28. Therefore, all operations must be planned for interrupted short periods of work, and so carried on as to preclude damage to unfinished items by submergence.

Rock for riprap is obtained at a quarry 3 miles up Saint John River. It is delivered to the job in both scows and trucks, and is rehandled by floating and traveling cranes where necessary.

A central concrete plant was installed last spring at Berth B, about ½ mile from the job, where all concrete except that for cylinder filling is produced. Aggregates are dredged from Courtenay Bay, transported by scows to a screening unit near the mixing plant. Pit run material for backfill is delivered to the same place, but is not screened. Mixed concrete is hauled in buckets by truck to the job for distribution by cranes.

Forms for the columns over the pile clusters, the front and tie walls and struts are steel panels carried by steel beams resting on the cylinders and piles. Slab forms are wood, supported by timbers shored from the cylinders and footings.

Because of the repeated inundation by tides, resulting in freezing and thawing to which much of the structure will be subjected in winter, careful attention

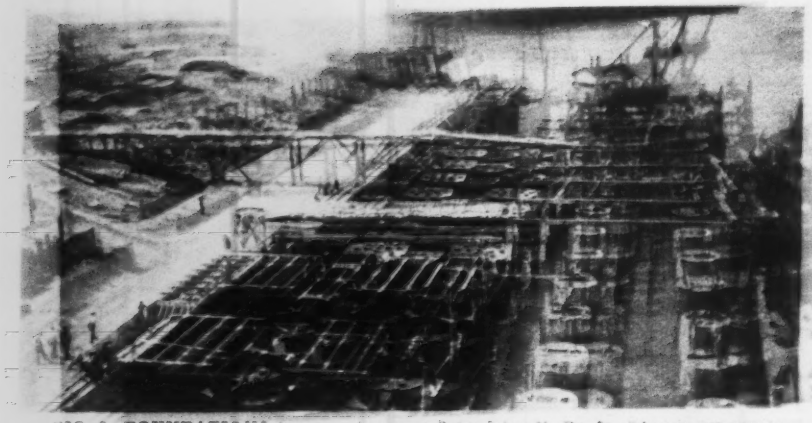


FIG. 5—FOUNDATIONS for new wharves at Saint John, N. B. At right are two rows of precast cylinders sunk to rock; circular caps over pile clusters are in the center, and timber relieving platform, carried on batter piles, is at left. All the work shown here is submerged 12 ft. twice daily by high tides.

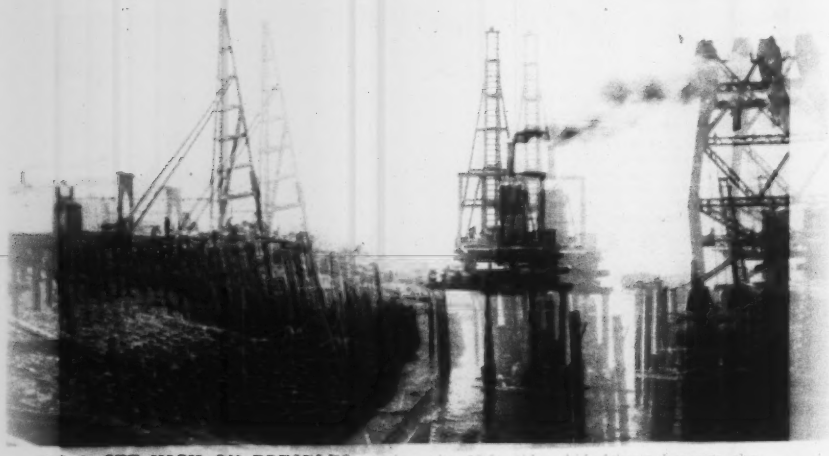
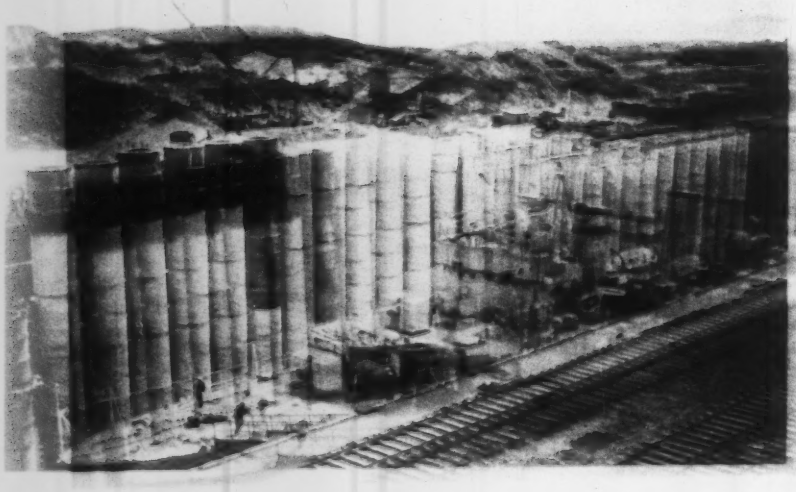


FIG. 6—SET HIGH ON TRESTLES to clear the 28-ft. tide, skid drivers hammer the piles down for support of the rear wharf deck columns and the timber relieving platform. At the right are the shear legs of the cylinder-setting floating crane.

FIG. 7—STRANGE BEDFELLOWS are a group of precast cylinders and a Canadian gunboat, both occupying the drydock where the caissons are manufactured.



field. All concrete, except the ... fill, is vibrated to increase the ... Compression test of 6x12-in. ... show an average 7-day strength of ... lb. per sq.in. and a 28-day strength ... 4,758 lb. Strengths of 5,000 lb. ... days and 5,600 lb. at 90 days have been obtained. Permeability tests ... richer mix concrete showed ... inum penetration of water in the ... day test at a hydrostatic pressure ... lb. per sq.in. is only 2 in.

Bulkhead construction

The bulkhead wall between ... and 5 is now complete but ... difficulty was encountered in ... struction because of ground ... The first operation in building the ... head was the driving of the ... platform piles with skid drivers ... from trestles at high tide level. ... the water was high, piles were ... levers as far as possible, then ... driven to final bearing at low tide.

Shortly after pile driving ... small cracks were observed in ... ground surface 100 ft. back of the ... wall, close to the foundations of ... gallery that parallels the bulkhead. ... inued driving widened these cracks ... opened others beyond the gallery ... lations. The gallery began to ... slightly toward the harbor and some ... the piles already driven showed tendency ... to shift. In an effort to check the ... ing, the ground was excavated to ... depth of 10 ft. between the relieving ... platform area and a line back of the ... gallery foundations. This procedure was ... fairly successful, though slight ... ment of the gallery and the piles was ... still observed. In the meantime ... of the gallery foundations had ... and settled as much as 12 in. ... horizontally and vertically. To ... structure from serious wracking, the ... lery posts were jacked up and ... above the foundation piers, and ... cables were run from top and bottom ... of the frame bents and anchored to ... loaded coal cars on a nearby siding. ... further serious movement of the gallery ... developed.

Construction of the laminated timber ... deck of the relieving platform and ... ing of the steel sheeting at the face ... lowed next. As soon as possible, wood ... forms for the concrete face wall were ... set up, made as watertight as possible. ... By correct timing of the pours, the ... concrete was kept above the level of ... rising tide. Concrete was furnished by ... the floating mixing plant.

Construction of the anchor wall ... lowed along with that of the face wall. ... The anchor was moved 60 ft. farther ... back than originally intended, or 100 ft. ... from the face wall, because of the ... previous ground disturbance. As soon as ... a stretch of anchor wall was complete, ... the tie rods were installed and tightened, ... and backfilling over the platform was ... started.

Once more trouble developed, for soon

is given concrete proportioning and ... classes of concrete are specified, one ... manufacture. It is desired to obtain a ... containing 658 lb. of cement per cu.yd., ... concrete as impervious to water as pos- ... the other 470 lb. Grading of the coarse ... sible. ... and fine aggregate is specified, but pro- ... Aggregates ... portioning is left to the engineer in the ... thoroughly ... cleaned and ... carefully proportioned. Two ...

it was observed that the face wall along the backfilled sections was slowly moving outward. Backfilling was immediately stopped back of, but was continued over the relieving platform. However, the face wall continued to move, and as none of the tie rods broke, it was determined that the whole structure—wall, platform and anchor—was shifting.

It was apparent that stabilization of the whole structure was necessary. Accordingly, some 20,000 cu.yd. of gravel was dumped against the outside face of the sheeting, distributed along the full length of the bulkhead up to low water level. This proved effective, and the structure was completed without further trouble. The ends of the gravel bank will be removed to permit docking of ships close to the bulkhead at Berths 4 and 5, but the center part will remain. New foundations were finally required for the grain gallery, and this structure was jacked back to its original position.

Direction

Present construction does not include transit sheds on the wharf. Funds for the sheds, which will complete the reconstruction of the harbor facilities destroyed by fire, are expected to be available next year. The work now under construction will cost about $2,750,000.

The construction is in charge of F. C. Jewett, representing the national harbors board. D. G. Ross is resident engineer, and J. H. McKinney is concrete engineer. All plans were prepared by the harbor commission staff under the direction of senior engineer V. C. Chesnut. Alex Gray is manager and chief engineer of the commission.

Contract for dredging and demolition of the old structure was held by the Saint John Dry Dock & Shipbuilding Co., Ltd. The Foundation Co. of Canada, Ltd., has the contract for all new construction work.

Slope Chaining in the Mountains

By A. M. Ockerblad
Assoc. Prof. of Applied Mechanics
University of Kansas

A NUMBER of years ago, the writer was engaged upon some rather extensive surveys of mountain land which was being acquired by the United States Forest Service. The first season's work showed clearly that the textbook method of "breaking chain" was too slow and cumbersome for use in mountain terrain. The writer, therefore, developed a very simple and efficient method for the reduction of slope chaining to horizontal measure. One phase of this method is described in an article in the *Engineering News-Record* for June 14, 1917. The present article is written to bring out some features of the method not contained therein.

The chainmen were furnished with a clinometer, reading to per cents of slope, and a 200-link tape in addition to the regular equipment. The program for one application of the tape was as follows: The front chainman was aligned by the rear chainman; then the rear chainman plumbed up from the point to the height of his eyes and the front chainman plumbed down from the height of his eyes to the point to be set, the tape thus being stretched at eye level. The point was set. The tape was dropped, and the chainmen, without moving their feet, determined the slope of the line between their eyes with their clinometers. The average of the two clinometer readings was taken as the slope on which the tape was held. The per cent of slope was recorded.

The closure distance was found by breaking chain, as experience showed that it was easier to break chain for the odd length than to compute it from the slope distance.

The correction to horizontal for a 200-unit tape on a 10 per cent slope is one unit, and for slopes between zero and 10 per cent the corrections vary as the square of the per cents. This comes from the well-known formula:

$$c = \frac{s^2}{2l}$$

substituting $l = 200$,

$$c = \frac{\left(\frac{s}{200}\right)^2}{\frac{2 \times 200}{200^2}}$$

$$= \text{(per cent of slope)}^2$$

The maximum error due to the use of approximate formula occurs for the 10 per cent slope and is .0075 units, making an error of 1 in 26,700.

CORRECTIONS
SLOPE CHAIN TO HORIZONTAL

% of Slope	Correction for 200 Units	% of Slope	Correction for 200 Units
1	010	31	8.978
2	040	32	9.520
3	090	33	10.078
4	160	34	10.652
5	250	35	11.240
6	360	36	11.824
7	490	37	12.422
8	640	38	13.034
9	810	39	13.662
10	1.000	40	14.302
11	1.202	41	14.958
12	1.428	42	15.604
13	1.674	43	16.264
14	1.930	44	16.938
15	2.206	45	17.624
16	2.508	46	18.298
17	2.830	47	18.986
18	3.160	48	19.708
19	3.532	49	20.394
20	3.888	50	21.118
21	4.274	51	21.826
22	4.678	52	22.544
23	5.086	53	23.274
24	5.526	54	24.014
25	5.986	55	24.766
26	6.446	56	25.500
27	6.920	57	26.244
28	7.418	58	26.998
29	7.908	59	27.734
30	8.436	60	28.506

The result from this type of chaining exceeded the expectations, in that the accuracy increased from about 1 in 1,000 to about 1 in 3,000 and the speed from about ½ to ¾ of a mile a day to a maximum of 3 miles a day, regardless of the terrain.

Because the chainmen held the tape at eye level, it was not necessary to cut as much brush as formerly, and this also increased the speed of the party.

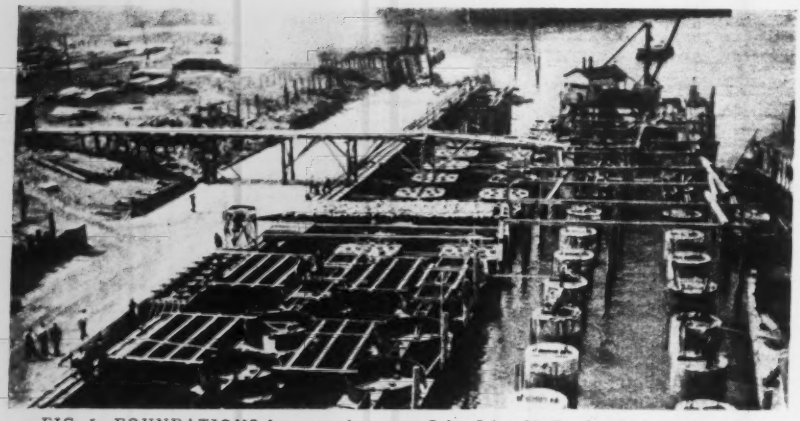
It is apparent that in a country free from brush, the tape may be held on the ground and the slope of the ground determined with the clinometer, thus eliminating the error due to plumbing.

Due to the length of the tape, it was found that there were very few slopes over 10 per cent, even in the rough country surveyed, and that there were none over 60 per cent. It is true that there were short stretches where the slope was excessive, but it was usually possible, by manipulating the stations, to arrange to shoot such places with the instrument. A correction table is appended for slopes over 10 per cent.

Experience shows that in rough country an accuracy of one part in 3,000 can easily be attained. It is thought that if accuracy greater than this is desired, correction for temperature must be applied. For low slopes, such as traverses along rolling country, where the slope does not exceed 10 per cent, it is probable that an accuracy of one part in 10,000 can be attained with proper attention to temperature and pull.

An analysis of the reasons for the increase in the accuracy when using this method gives us an interesting side light on the theory of errors. In taping, all errors of alignment tend to increase the recorded distance as compared with the true distance. The horizontal alignment is easy to control, but the vertical alignment is difficult, especially on steep terrain. The slope as determined above is as likely to be greater than the true value as it is to be less, and so changes the type of error from cumulative to compensating, the first varying directly with the number of opportunities for error and the latter as the square root of the number of opportunities.

The system of taping as outlined above was used on the survey of a large number of closed traverses and gave such excellent results that the writer has no hesitation in recommending its use to surveyors engaged in running lines in rough country.



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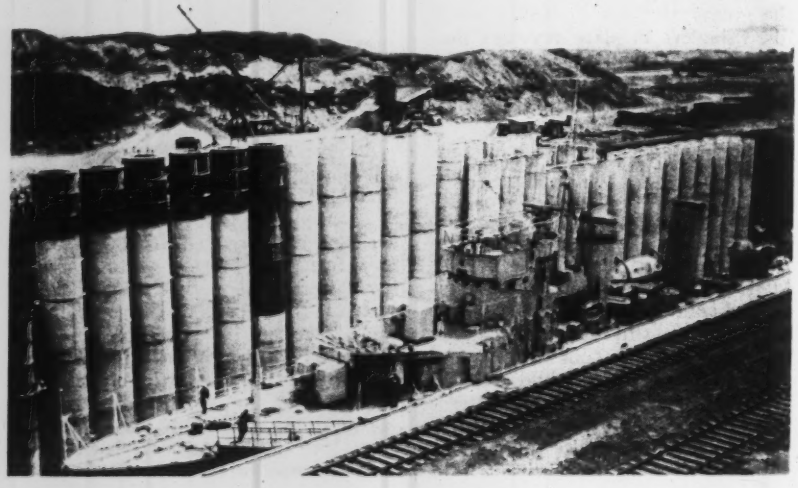

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Bulkhead construction troubles

The bulkhead wall between Berths 4 and 5 is now complete, but considerable difficulty was encountered in its construction because of ground movement. The first operation in building the bulkhead was the driving of the relieving platform piles with skid drivers working from trestles at high tide level. When the water was high, piles were set and driven as far as possible, then they were redriven to final bearing at low tide.

Shortly after pile driving started, small cracks were observed in the ground surface 100 ft. back of the face wall, close to the foundations of a grain gallery that parallels the bulkhead. Continued driving widened these cracks and opened others beyond the gallery foundations. The gallery began to shift slightly toward the harbor, and some of the piles already driven showed tendency to shift. In an effort to check the sliding, the ground was excavated for a depth of 10 ft. between the relieving platform area and a line back of the gallery foundations. This procedure was fairly successful, though slight movement of the gallery and the piles was still observed. In the meantime, some of the gallery foundations had shifted and settled as much as 12 in., both horizontally and vertically. To save the structure from serious wracking, the gallery posts were jacked up and wedged above the foundation piers, and guy cables were run from top and bottom of the frame bents and anchored to loaded coal cars on a nearby siding. No further serious movement of the gallery developed.

Construction of the laminated timber deck of the relieving platform and driving of the steel sheeting at the face followed next. As soon as possible, wood forms for the concrete face wall were set up, made as watertight as possible. By correct timing of the pours, the concrete was kept above the level of the rising tide. Concrete was furnished by the floating mixing plant.

Construction of the anchor wall followed along with that of the face wall. The anchor was moved 60 ft. farther back than originally intended, or 160 ft. from the face wall, because of the previous ground disturbance. As soon as a stretch of anchor wall was complete, the tie rods were installed and tightened, and backfilling over the platform was started.

Once more trouble developed, for soon

it was observed that the face wall along the backfilled sections was slowly moving outward. Backfilling was immediately stopped back of, but was continued over the relieving platform. However, the face wall continued to move, and as none of the tie rods broke, it was determined that the whole structure—wall, platform and anchor—was shifting.

It was apparent that stabilization of the whole structure was necessary. Accordingly, some 20,000 cu.yd. of gravel was dumped against the outside face of the sheeting, distributed along the full length of the bulkhead up to low water level. This proved effective, and the structure was completed without further trouble. The ends of the gravel bank will be removed to permit docking of ships close to the bulkhead at Berths 4 and 5, but the center part will remain. New foundations were finally required for the grain gallery, and this structure was jacked back to its original position.

Direction

Present construction does not include transit sheds on the wharf. Funds for the sheds, which will complete the reconstruction of the harbor facilities destroyed by fire, are expected to be available next year. The work now under construction will cost about $2,750,000.

The construction is in charge of F. C. Jewett, representing the national harbors board. D. G. Ross is resident engineer, and J. H. McKinney is concrete engineer. All plans were prepared by the harbor commission staff under the direction of senior engineer V. C. Chesnut. Alex Gray is manager and chief engineer of the commission.

Contract for dredging and demolition of the old structure was held by the Saint John Dry Dock & Shipbuilding Co., Ltd. The Foundation Co. of Canada, Ltd., has the contract for all new construction work.

Slope Chaining in the Mountains

By A. M. Ockerblad
Assoc. Prof. of Applied Mechanics, University of Kansas

A NUMBER of years ago, the writer was engaged upon some rather rather extensive surveys of mountain land which was being acquired by the United States Forest Service. The first season's work showed clearly that the textbook method of "breaking chain" was too slow and cumbersome for use in mountain terrain. The writer, therefore, developed a very simple and efficient method for the reduction of slope chaining to horizontal measure. One phase of this method is described in an article in the *Engineering News-Record* for June 14, 1917. The present article is written to bring out some features of the method not contained therein.

The chainmen were furnished with a clinometer, reading to per cents of slope, and a 200-link tape in addition to the regular equipment. The program for one application of the tape was as follows: The front chainman was aligned by the rear chainman; then the rear chainman plumbed up from the point to the height of his eyes and the front chainman plumbed down from the height of his eyes to the point to be set, the tape thus being stretched at eye level. The point was set. The tape was dropped, and the chainmen, without moving their feet, determined the slope of the line between their eyes with their clinometers. The average of the two clinometer readings was taken as the slope on which the tape was held. The per cent of slope was recorded.

The closure distance was found by breaking chain, as experience showed that it was easier to break chain for the odd length than to compute it from the slope distance.

The correction to horizontal for a 200-unit tape on a 10 per cent slope is one unit, and for slopes between zero and 10 per cent the corrections vary as the square of the per cents. This comes from the well-known formula:

$$c - a = \frac{h^2}{2c}$$

substituting $c = 200$,

$$c - a = \frac{\left(\frac{h}{200}\right)^2}{\frac{2 \times 200}{200^2}}$$

$$= (\text{per cent of slope})^2$$

The maximum error due to the use of approximate formula occurs for the 10 per cent slope and is .0075 units, making an error of 1 in 26,700.

CORRECTIONS
SLOPE CHAIN TO HORIZONTAL

% of Slope	Correction for 200 Units	% of Slope	Correction for 200 Units
1	010	31	8.978
2	040	32	9.520
3	090	33	10.078
4	160	34	10.652
5	250	35	11.240
6	360	36	11.824
7	490	37	12.422
8	640	38	13.034
9	810	39	13.662
10	1.000	40	14.302
11	1.202	41	14.958
12	1.428	42	15.604
13	1.674	43	16.264
14	1.930	44	16.938
15	2.206	45	17.624
16	2.508	46	18.298
17	2.830	47	18.986
18	3.160	48	19.708
19	3.532	49	20.394
20	3.888	50	21.118
21	4.274	51	21.826
22	4.678	52	22.544
23	5.086	53	23.274
24	5.526	54	24.014
25	5.984	55	24.766
26	6.444	56	25.500
27	6.920	57	26.244
28	7.414	58	26.998
29	7.908	59	27.734
30	8.436	60	28.506

The result from this type of chaining exceeded the expectations, in that the accuracy increased from about 1 in 1,000 to about 1 in 3,000 and the speed from about ½ to ¾ of a mile a day to a maximum of 3 miles a day, regardless of the terrain.

Because the chainmen held the tape at eye level, it was not necessary to cut as much brush as formerly, and this, also, increased the speed of the party.

It is apparent that in a country free from brush, the tape may be held on the ground and the slope of the ground determined with the clinometer, thus eliminating the error due to plumbing.

Due to the length of the tape, it was found that there were very few slopes over 10 per cent, even in the rough country surveyed, and that there were none over 60 per cent. It is true that there were short stretches where the slope was excessive, but it was usually possible, by manipulating the stations, to arrange to shoot such places with the instrument. A correction table is appended for slopes over 10 per cent.

Experience shows that in rough country an accuracy of one part in 3,000 can easily be attained. It is thought that if accuracy greater than this is desired, correction for temperature must be applied. For low slopes, such as traverses along rolling country, where the slope does not exceed 10 per cent, it is probable that an accuracy of one part in 10,000 can be attained with proper attention to temperature and pull.

An analysis of the reasons for the increase in the accuracy when using this method gives us an interesting side light on the theory of errors. In taping, all errors of alignment tend to increase the recorded distance as compared with the true distance. The horizontal alignment is easy to control, but the vertical alignment is difficult, especially on steep terrain. The slope as determined above is as likely to be greater than the true value as it is to be less, and so changes the type of error from cumulative to compensating, the first varying directly with the number of opportunities for error and the latter as the square root of the number of opportunities.

The system of taping as outlined above was used on the survey of a large number of closed traverses and gave such excellent results that the writer has no hesitation in recommending its use to surveyors engaged in running lines in rough country.

Desilting Works for Loup Project

Traveling bridge over a long settling basin carries pumps moving transversely and discharging into a launder which dumps sludge into channel paralleling basin for ultimate discharge into the river

THE LOUP RIVER on which the Loup River Public Power District of Nebraska is now building two waterpower plants carries a very large quantity of silt at the point where the 35-mile power canal is to take water from the river, so much that it is estimated at times 10,000 tons of silt a day will have to be removed to keep the canal from being clogged. Hence, from the start of operations, silt removal has been a major problem of the engineering force. Beginning more than a year ago the engineering staff made studies of possible ways for eliminating the silt and submitted designs to the PWA for approval. Most of the earlier designs were based on the use of stilling basins in the natural channel of the river from which the deposited silt was to be scoured by turning floodflows through the basin. But such plans were discarded in favor of one in which silt is to be removed from an artificial stilling basin.

Construction of the project was begun in 1934 (*ENR*, Oct. 11, 1934, p. 469) and work on the canals and two power houses is well along. Contracts for construction of the desilting works, other than mechanical equipment, were let recently. These works consist of a long diversion weir, river control gates, an intake structure and a long stilling basin from which silt will be removed by dredges mounted on a moving bridge.

The Loup River is to be diverted across a point of land through a new channel across which will be built a low control weir. At the left end is an intake structure leading into the head of the settling basin which is 2 mi. long, 200 ft. wide on the bottom and is to carry a water depth of 16 ft. The control weir will divert a useful flow of 3,000 sec.-ft. or less.

Under full operating conditions and when empty the settling basin is designed for a velocity of 0.7 ft. per second. Spanning this elongated basin is the traveling bridge having a span of 300 ft. and carrying two 24-in. dredge pumps. The pumps will be movable back and forth across the bridge and in combination with the bridge movement will permit draft from all parts of the basin. The pumped silt and water or sludge will be discharged into a trough on the bridge which in turn will carry the sludge to the right bank or river side of the settling basin and dump it into a concrete-lined channel running parallel to the basin. The concentration of sludge pumped will be controlled by the rate of movement of the pumps. From the concrete channel the sludge will flow into a metal flume which follows along the river bank for 3,000 ft. At frequent intervals the sludge is to be discharged into the river.

At the lower end of the settling basin is a control weir which will serve to maintain the proper water level and low velocity in the basin. Below this structure begins the regular section of the 33-mi. power canal which will carry the water to the Monroe and Columbus power houses. (See *ENR*, Aug. 6, p. 181, article on bridges over canal.)

Intake

The intake structures comprise a river control weir, an intake into the head of the settling basin and a control gate section. These structures are in the point of land across which the new diversion is to take place with the control gate section transverse to the line of flow. The intake and weir make two sides of a spreading pocket, their downstream ends abutting on either end of the control gate section.

The control weir, 1,050 ft. long, has its crest at El. 1,574, about ground level, and 3 ft. above the elevation of the entrance to the settling basin. It consists of a concrete slab, 20 ft. wide, with a narrow weir wall, 8 ft. high, 15 in. thick at the top, and 21 in. thick at the base. This is located at the upstream toe. A wall 24 in. high at the lower side forms a stilling pool 2 ft. deep. The slab varies in thickness from 18 in. at the upstream side to 12 in. downstream. Both upstream and downstream edges (toes) of the weir slab are protected from undercutting by longitudinal lines of steel sheet piling, 10 and 20 ft. deep respectively, plus transverse lines at 200-ft. intervals.

Three-course gravel pockets under the downstream toe are spaced on 3-ft. centers to prevent uplift as well as to drain out the stilling pool in dry weather. Imbedded in the top of the weir at 6-ft. intervals are pockets for flashboards consisting of 2-in. black iron pipe 12 in. long.

Below the weir only pioneer cuts, 100 ft. wide and about 7 ft. deep, were excavated leaving the central portion, 850 ft. wide, to be scoured out by the river in flood. Similarly pioneer cuts were made upstream back to the existing river channel except that the right cut was made 300 ft. wide. Cuts 150 and 100 ft. wide were also made upstream and downstream from and parallel to the control weir.

Basin intake

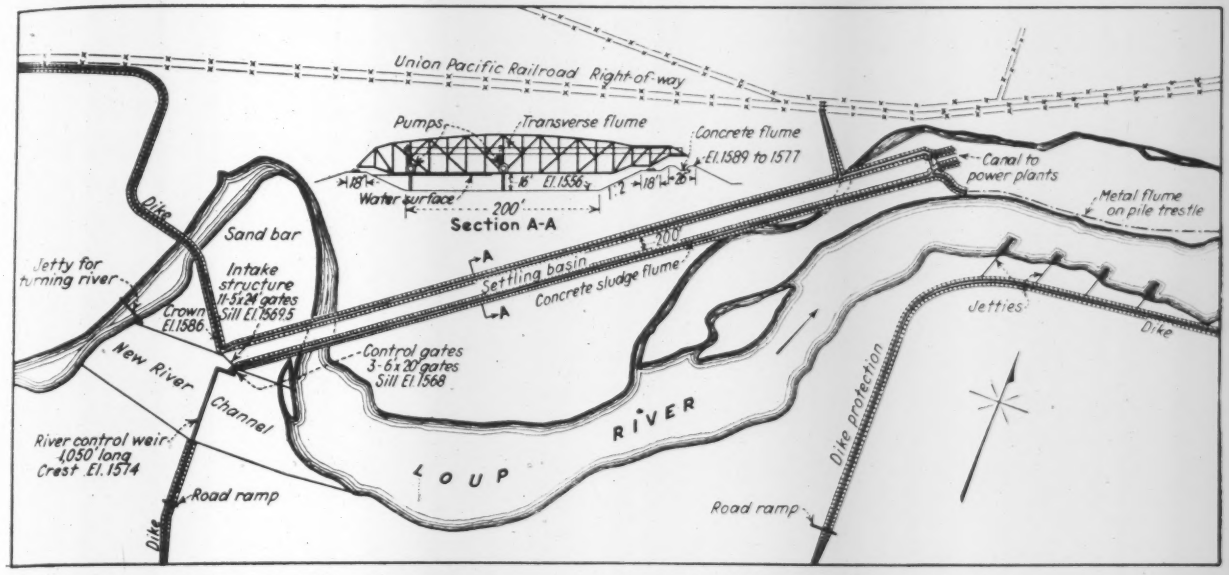
The settling basin intake structure consists of an 18-in. slab, 20 ft. 11 in. wide, of much the same type as the control weir slab except that 15-ft. steel sheet pilings are to be driven under the upstream toe only and there is no stilling pool, the upstream toe being raised 17 in. above the general level of the slab. Under the downstream toe is a gravel drain trench, 24 in. wide, imbedded in the concrete footing. Egress of water is through 3-in. holes, 3 ft. 3 in. on centers, just below the tainter gate sill. Downstream, the floor area is protected by an 8-in. slab for 15 ft. and then by a 4-in. slab some 200 ft. to the entrance of the settling basin proper. Well points are inserted in this bottom paving on 15-ft. centers both ways. They are driven to variable depths and brought up through the slab with 2-in. pipe terminating in elbows facing downstream. The 4-in. slope paving bordering this area is laid on a 4-in. gravel layer and drains are placed on 10-ft. centers.

Ten piers, 24-in. wide, divide up the 284 ft. total length into eleven underflow openings controlled by tainter gates anchored at the downstream face of the piers and seated on a 6-in. I-beam set in a grout pocket in the foundation slab. Dropping to the level of the center of the gate axle is a 15-in. curtain wall between piers, thus limiting the gate opening to 5 ft. high by 24 ft. long. Provision is made for stoplogs, 12 ft. long by the insertion of 8-in. structural steel H's opposite stoplog grooves near the upstream ends of the piers.

A concrete bridge 9 in. thick provides a walkway and operating floor, 9½ ft. wide.

Control gates

Between the ends of the control weir and the basin intake is the control gate structure, 64 ft. long, providing for three 6x20-ft. tainter gates. It rests on a slab 38 ft. wide varying in thickness from 30 in. directly under the gate sill to 12 in. downstream. Sheet piles, 10 ft. long, under the upstream and 20 ft. under the downstream toe protect against scour and undercutting. A gravel trench



HEADWORKS and desilting basin at the head of the canal for Loup River hydro-electric project.

under the gate sill and well points on 15-ft. centers 9 ft. from the down-stream edge provide for relieving uplift.

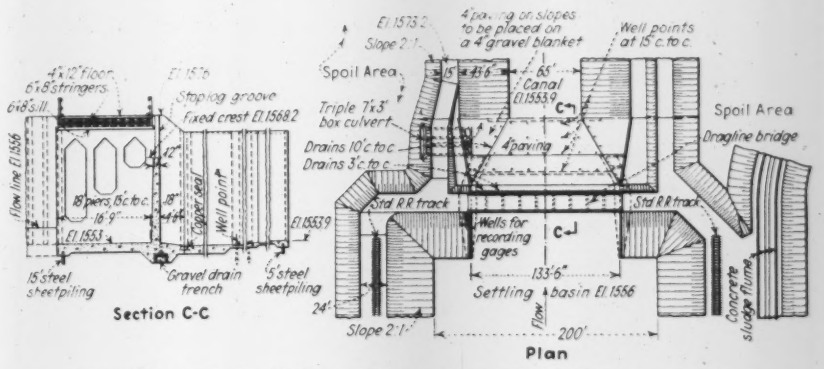
The radial gates of 12-ft. radius are centered 8 ft. above the floor and are controlled from an overhead bridge 18 ft. above the gate sill.

Desilting basin

The desilting basin, 2 mi. long and 200 ft. bottom width, is formed by earth embankments with 2 on 1 slopes carrying standard gage railroad tracks to support the ends of the traveling pump bridge. These tracks are gravel ballasted and have creosoted ties. The embankment on the river side also supports a concrete-lined channel for sludge disposal, the upper end being built up to increase the slope. This channel is 3½ ft. wide on the bottom, has 1½ on 1 side slopes and is 4 ft. total depth. From the center of the settling basin to the center of the sludge channel is 197 ft. The half-round metal flume that forms the downstream extension of the sludge channel is 8 ft. 3¼ in. in diameter.

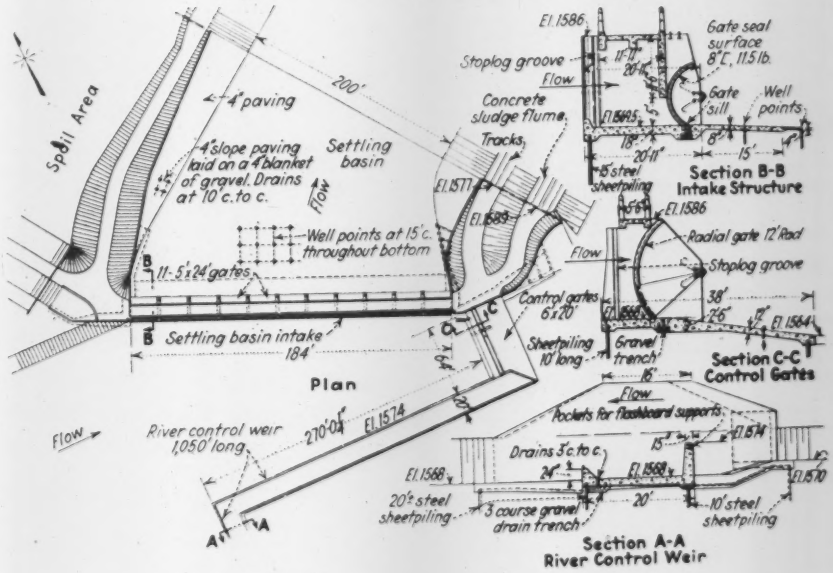
The concrete slabs for the sludge flume are to be built in alternate sections, the first slabs to be 20 ft. long and the intermediate ones 10 ft. long. Construction joints are to be picked, cleaned and flushed with grout prior to making the second deposition. Reinforcement is electric welded wire fabric of No. 0 gage spaced on 6-in. centers and the fabric lapped 12 in.

At the lower end of the settling basin in the transition to the canal section is a dragline bridge, 16 ft. wide, for 75-ton loading. At the lower end of the 18-in. concrete diaphragm piers, spaced on 15-ft. centers supporting the timber deck, is a fixed concrete weir, 15 ft. high above the 18-in. foundation slab. Above the weir are grooves for stoplogs, 7 in. thick, to control the elevation of the



CONTROL AND SKIMMING WEIR and transition into the power canal at lower end of the settling basin.

INTAKE TO SETTLING BASIN, control gates and control weir for the Loup River power canal.



water in the basin. Two 24x30-in. wells for recording gages are located at the left end of the bridge.

Excavation for the control work is well along. Morrison-Knudsen, Boise, Idaho, is contractor for the excavation and concrete structures. On Aug. 6 Worden-Allen Co., Chicago, were awarded contract for the gates and hoists. Contracts for the traveling bridge and dredging pumps are expected to be let within a few weeks. The work is being designed and carried out under the direction of the Harza Engineering Co., Chicago, with Erik Floor of that company in resident charge and Fred C. Albert as supervisory engineer for the Loup River Public Power District, a PWA financed local organization made up of county appointed officials.

London Water Supply Augmented by New Underground System

Radial well collector installation is used to supplement London supply during dry season—An improved technique in driving pipe screens horizontally facilitates large draft on sub-surface water basin

By Ross Nebolsine, Manager
Ranney Water Collector Corp., New York, N. Y.

THE WATER SUPPLY of London, England, was increased during the drought of 1934 by water drawn from underground sources through a well system fed by an improved type of radial collector. Since the 1934 drought the system has been put into use in dry periods and has worked successfully. Within a short time work will be begun on a similar installation in this country.

The pipe screen collector that is a novel element of the London system was developed in this country by Leo Ranney, a petroleum engineer of California, as the result of experimental work in connection with the recovery of residual oil from sands and shale. Patent rights are now held by Mr. Ranney.

Radial well development

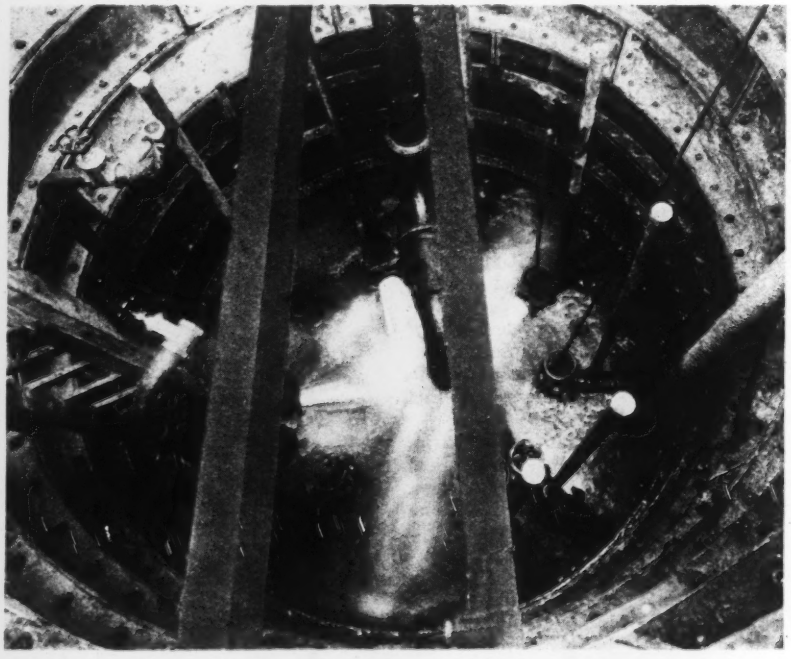
For certain locations, engineers have long recognized the advantages of wells equipped with a number of radiating collector pipes. In the oldest examples of Europe, horizontal radial screen pipes discharging into a central well were buried in trenches. The very limited depth to which this could be done excluded all locations where the groundwater was not perfectly stable and near the surface. Later, radial wells were built by simply forcing horizontal strainer pipes of small diameter into the ground through openings in the walls of the shaft. Depending upon the ground and the skill employed, two or three-inch pipes have been projected as much as 50 or 60 ft.; pipes of larger diameter but of much shorter length have also been projected. This procedure, however, results in compressing the ground around and ahead of the pipe so that the permeability of the adjacent soil is greatly reduced and silting is encouraged. Jetting may slightly facilitate the projection of the pipes, but it does not fundamentally improve the process; besides, jetting operations are primarily adapted only to projection from the surface.

In applying the improved collector to water supply work a concrete shaft 10 to 25 ft. in diameter is sunk into the water-bearing strata and from special portholes left in the shaft walls screen pipes are projected out into the strata by power operated hydraulic jacks. The outer end of each screen pipe is equipped with a special, perforated boring head which communicates with a removable, imperforate inner pipe that extends back into the shaft. A sliding packer maintains a fluid type stoppage of the annular space between the two pipes during the boring operations. The driving block that transmits the pressure of the jacks to push out the screen pipes in successive sections is arranged to receive the rear end of the imperforated inner sand discharge pipe, and to control the flow therefrom. The portholes in the shaft walls are equipped with backwash pipes and gate valves, by which, after completion, the flow from each tube can be independently controlled, and the screen pipes individually connected with the main pump for backwashing purposes.

Boring head action

The process permits the formation of a subterranean gravel pack around each horizontal screen pipe. As the pipe is pushed out there is progressively removed an optimum amount of fine materials from the expanding body of ground just ahead of the boring head, leaving a pack of coarser material about 1-ft. in thickness around and adjacent to the screens. The volume of fines

FIG. 1 — HORIZONTAL STRAINER PIPES driven radially from a central well increase rate of water collection at Sunbury Cross for the London Metropolitan Water Board.



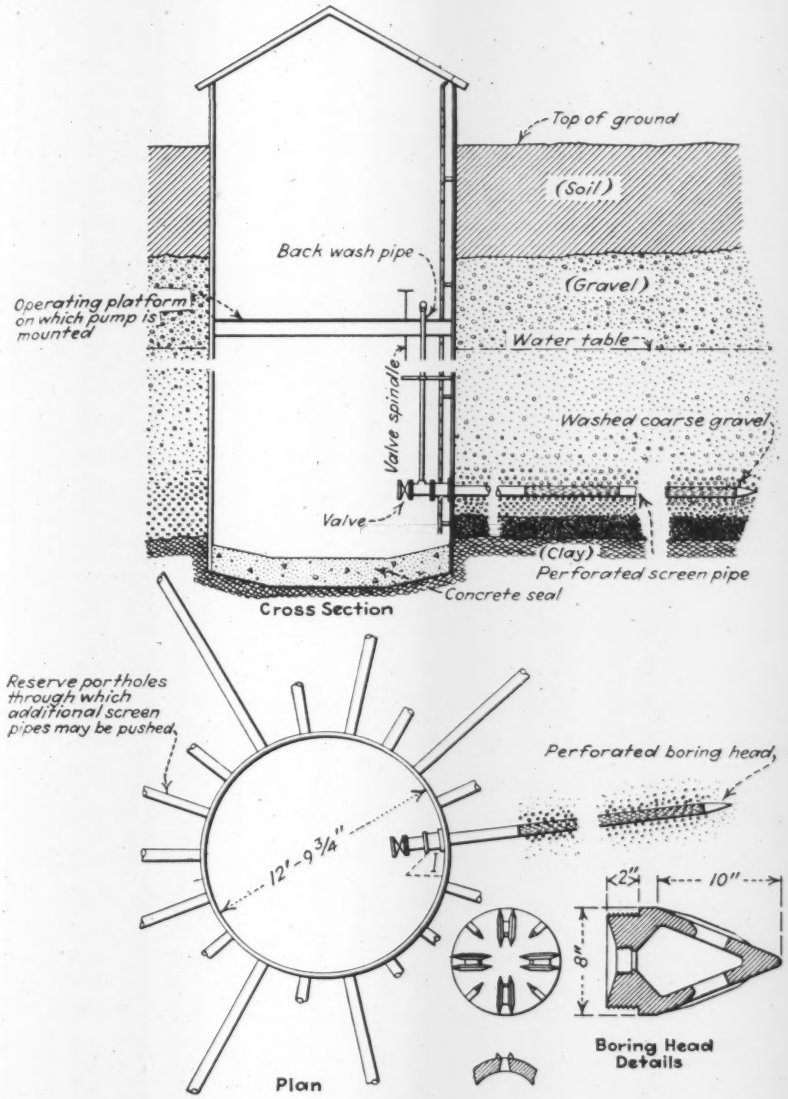


FIG. 2—DIAGRAMMATIC LAYOUT of a radial well installation and details of the boring head. By means of the latter fine material can be removed and a pack of coarser material formed around each pipe screen.

so removed is ordinarily about three times the displacement caused by the pipe strainer.

It is possible by this process to project large diameter screens to relatively great distances. The permeability of the ground is increased where the velocity of infiltration is high and this greatly reduces the head required to force a given quantity of water into the shaft. The velocity of water through screen openings may be kept down to .02 of a foot per second, too low to carry sand or silt. By this method of forming the gravel pack, it becomes a rationally graded filter with the coarser and most permeable material lying against the screen. Developments will further perfect this filter, and thus prevent the entrainment of the fine material from the ground during normal operations. If over-pumping takes place, no clogging of the pack will occur.

Should the collector and the ground fail to maintain the original yield, the static head of water in the ground can be employed to flush, or the full force of the pump to backwash, individually and successively, each screen pipe and its surrounding filter medium.

The London installation

The London installation is at Sunbury Cross in the Thames River valley. Here a shaft of 12½ ft. in diameter was sunk to a depth of 22 ft. in ground consisting of a 20 ft. alluvial fill of sand and gravel overlying a thick bed of clay. There were nine radiating screen pipes, 7 in. in internal diameter and up to 165 ft. long, projected horizontally into the water-bearing strata one foot above the clay. These pipes were projected into the ground during construction at a rate up to 100 ft. per day.

Only four of the longest collector pipes were used, and they supplied an average of 1,800,000 gal. daily during the drought season when the undisturbed water table was only 5 ft. above the screens. Normally, with the water table about 11 ft. above the pipes, this capacity is more than doubled.

Pressure head loss

The difference in pressure of the water in the pipe and the nearby ground is only a small fraction of a foot, due to the large screen area and the extensive open filter pack around the pipe. Observation showed that all but a few inches of total available head is used to maintain the inflow from the surrounding ground, through a broad, flat, shallow water-bearing stratum, the maximum wetted depth of which was 6 ft. during the drought and 12 ft. normally. This installation was made during the unprecedented drought of 1934 and has been used since during dry seasons, when supplementary sources of supply are drawn upon. It forms a part of the permanent plant now in use by the Metropolitan Water Board.

Adapted to recharging

Experimental evidence has been obtained which indicates that the radial well process may also be found useful for water conservation purposes as a means for recharging underground storage. The replenishment of underground basins is frequently prevented by strata of overlying clay. Even when all the ground is apparently porous, the horizontal stratification of material, if of alluvial origin, may offer great resistance to percolation.

The radial well process can probably be applied to best advantage in locations where the superficial sand and gravel are either below or adjacent to a river, or in the path of lateral underground flow, where underlying porous formations of sufficient volume are found at not too great a depth. Thus, from a shaft located at or near a stream bank, multiple screen pipes projected under the water course could be employed to abstract water filtered through the river bed and adjacent sand and gravel. This naturally filtered water may be conveyed down the shaft, past clay beds or stratified alluvial material and fed to depleted underground reservoirs by exposure of the lower porous formations.

CURRENT HIGHWAY PROBLEMS—IV

Fitting the Road to Future Traffic

Operating requirements call for broader vision on highway widths, line, grade and roadside control—In planning, each element must be given its proper weight with respect to long-time needs rather than immediate necessity.

By M. W. Torkelson
Director of Regional Planning, Wisconsin State Planning Board Madison, Wis.

IN HIGHWAY IMPROVEMENT *of recent times the geometrical design of the road has lagged far behind the structural design of pavements. Today road transport is severely handicapped by deficiencies in line, profile and width of roadway and the problem of correcting these deficiencies squarely confronts highway engineers. It is equally plain that the problem cannot be solved by grudging concessions to immediate necessities; a far look ahead to the possibilities of road transport and regional development is a positive requirement for permanent solution. It is in this forward attitude of mind that the following discussion of fitting the road to future traffic has been undertaken. The argument put forward calls for changes in no small way of present practices in line and roadway design. In so stating the situation, a bold thinker and speaker has given highway engineering much that it can consider with profit to highway transport.* EDITOR.

DEFINITE PROGRESS may be noted in the design of road structure to meet operating requirements. In rough enumeration the elements of road structure are travel surface, shoulders, ditches, slopes, width, line and grade. In highway design none of these can be determined independently of the operating requirements of road transport. Indeed, their consideration should project far into long-time planning for regional development. It is in this broader significance that design for operation is considered here.

The supreme test of any construction accomplishment is the satisfaction it continues to give in operation. This is particularly true of a road. While secondary highways and land-service roads may be changed rather easily, the major highways, as we now build them, will probably determine the routes of travel for centuries. Once built, a major highway cannot be lightly changed. Therefore, it is essential that it shall be built so as to make major changes unnecessary as operation puts greater demands on road structure.

Road elements appraised

The component parts of a highway are: the right-of-way, which is the site, or the land on which the highway is built; the grading, which is the prepared foundation on which the pavement and other structures are built; the structures, including principally the pavement or other surfacing, the bridges and culverts, the signals, etc.; and the roadside improvements including principally the desirable landscaping and other plantings.

The essential qualities of a highway are three; utility, safety and beauty, all are definitely tied in with operation. The extent to which money may be invested in highways to secure these qualities varies according to the use of the road, either present or potential. Also the emphasis that should be placed on the respective component parts of the road will vary according to the use of the road. The first essential of all roads is an all-weather surface.

For local roads in communities of scanty populations, surfacing is more important than grading. Such roads can follow the surface of the ground quite closely through farming country, without too great grades and so placed as to favor snow removal. The logical location for farm-service roads is along property lines in areas where the topography and other conditions will permit and especially where the land is laid out in sections. The distance traveled on such roads is usually short, so that speed is no great advantage and sharp curvature will serve traffic without any great loss of time.

As the traffic service of the road increases, profile and alignment become ascendent and right-of-way and grading assume major importance. Adequate grading cannot be carried out without ample right-of-way and so in a major highway the right-of-way is of first importance and grading is second. If these two components of the major highway are adequate, the structures and roadside improvements will always be built to the proper standards. The great danger is that highway authorities will be browbeaten into building high-type pavements and expensive structures on poor locations inadequately graded.

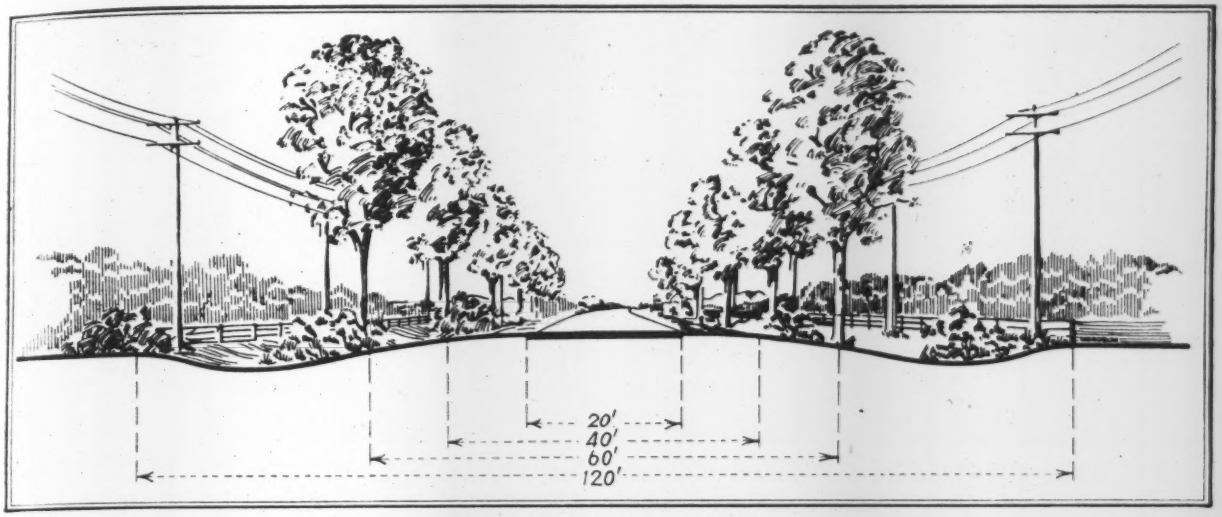
Though structures are temporary in a long-range consideration of highway development, there is no reason why a pavement cannot serve thirty years, a full human generation, or even longer. High-type pavements and so-called permanent structures involve heavy expenditures. We must not spend substantial sums to build roads that will have to be torn out and replaced because of obsolescence, long before they are worn out or paid for. Just this thing is happening on a large scale in the United States today.

When any improvement on a major highway is considered, the policy should either be to spend the very smallest possible amount that will meet the immediate necessity, or to build the road to the very best obtainable alignment and grades, and so as to be capable of expansion to meet future increased demands of traffic without the large scale scrapping of serviceable pavements and other structures. This will mean getting the best alignment and grade that the locality affords.

Logical line and grades

Standards of grades and line will vary according to topography and traffic. Judgment will have to be exercised. In level or only slightly rolling country, it will indicate that the alignment and grade should be such that operating conditions will be substantially equal to those on roads that are straight and level. Although there has been much said and written regarding the desirability of reducing speeds of motor traffic, very little effective work to that end has been done and the reason is that the vast majority of people, in their hearts, want these high speeds. Though some of us may think we are approaching the limit of human endurance in the not uncommon speeds of 70 and 80 miles per hour, people were of the same opinion when the railroads first attained the hitherto unheard of speed of 30 miles per hour.

In rough topography we must fit the country as best we can, and uniformity in grade, sight distance and curvature



ELEMENTS of across-road profile desirable in a modern two-lane paved rural highway

must be the criterion. A road with a paved width of 20 ft. or more, with many grades and curves is not dangerous unless some grade is decidedly steeper, or some curve decidedly sharper, than the driver can reasonably expect. Sudden and unexpected increased demands on the driver are what do the damage. At each end of a 21-mi. tangent that the driver knows of, there is a sharp turn. Regardless of large warning signs directly facing the driver, and visible for a half mile or more, and other warning signs in plain sight, vehicles have repeatedly driven straight into the warning signs.

The problem of grades

As they affect the operation of the ordinary passenger automobile, any grade of 8 per cent or less, which is almost always attainable, is of no special difficulty except in one particular, namely, its effect on sight distance. Short vertical curves over summits are commonly-recognized hazards. Another hazard results from the slow movement of trucks up steep grades, which results in a queue of faster-moving overtaking vehicles being forced to trail the slow-moving truck the entire distance up the hill. Impatient drivers will find it difficult to restrain themselves from attempting to pass in spite of statutes against such passing and despite the great risk involved. Where such places occur on roads with two or three lane carrying a traffic which makes considerable demands on their capacity, it may be desirable to build sections of divided highways of sufficient length to permit overtaking vehicles to pass in safety.

The operating requirements for line and grade for major highways may be summarized by stating that they must be the very best reasonably attainable, approaching straightness and levelness even at heavy expenditures for right-of-way and grading. The better the alignment and grades in any road, the more dangerous is a sudden sharp curve or steep hill.

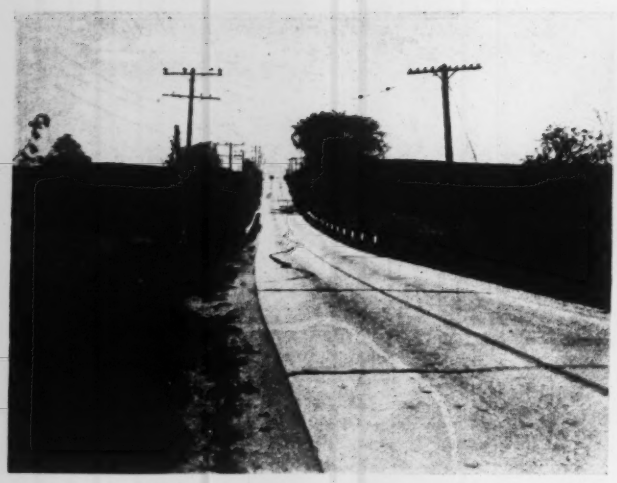
It is possible to be more specific with reference to widths than in the case of alignment and grades because widths are basically functions of the widths of vehicles, which have not varied greatly, and which are practicable to regulate by statute. In most states the maximum permissible width of vehicles is 8 ft., and the acceptance of 1 ft. outside of this width on each side, as a reasonable margin, has resulted in the prevalent standard 10-ft. lane. There has not yet been much demand for lanes wider than 10 ft. but if speeds increase it is conceivable that the demand for wider lanes will also increase, even though the maximum legal width of vehicles is not increased. However, it appears that the 10-ft. lane is still reasonably adequate for present vehicles, and will continue so to be.

Ten-ft. lanes adequate

Adherence to the standard gage for railways has not prevented the development of an adequate rail transportation system, which performs 80 per cent of all transportation (in ton-miles) in the United States. It would scarcely seem warranted to increase the present generally accepted maximum widths of motor vehicles which at present perform only 1.86 per cent of the transportation. (*ENR*, June 11, 1936.) Such a step would tend toward rendering obsolescent practically the entire mileage of pavements built during the last ten years. There is no highway transportation need that cannot be filled with vehicles that can be operated safely and efficiently on a 10-ft. pavement lane. There will be exceptional situations where wider lanes will be advisable, but the occasional occurrence of such pavements should not be considered valid reasons for operating wider vehicles on them.

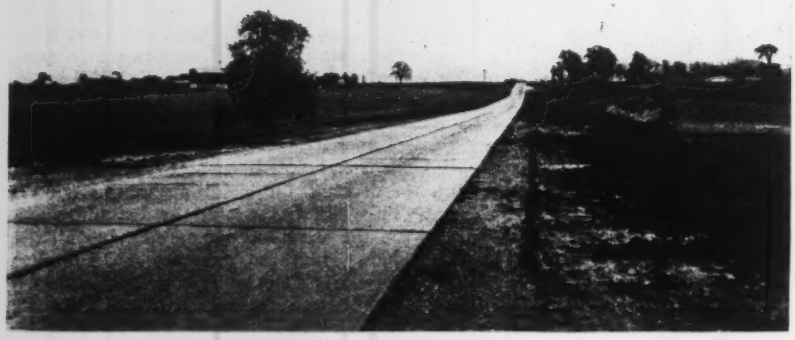
Not until recent years have shoulder widths have been considered on any rational basis in respect to highway operation. When 18 ft. was the prevailing width of two-lane pavements, the roadbeds were usually 24 or 26 ft. wide. It was assumed that the only occasion for a wheel being off the pavement was through some mischance, and that the purpose of the shoulder was to afford support until the vehicle might return completely to the pavement. No serious concern was felt over stopping on the pavement; perhaps this was not necessary in view of the then prevailing speeds. Modern speeds, however, have changed all this. The shoulder has a number of functions which demand that it shall be of the full width of a traffic lane, and surfaced with material, which though not equal to the pavement, yet should be travelable for slow moving traffic in all weathers.

Animal-drawn vehicles should be required to use these surfaced shoulders; the same is true of tractors which generally travel at slow speeds. All stops of vehicles should be in the clear of the pavement and the only available place for such stops is on the shoulder. In certain northern regions there is still a demand for sleighing in the winter. This can be secured by leaving snow on the shoulder while removing all the snow from the pavement. The outer edge of such a shoulder also offers a place for a footpath. In the outskirts of cities there should be sidewalks located right out at the fence line. However, out in the open country, this location does not seem practicable. Every pedestrian is hoping for a ride and will be walking out near the pavement where there is the best chance of getting picked up. A footpath at the outer edge of the shoulder can be easily maintained and will be used by pedestrians.



A DEEP CUT adjacent to a high fill with 3-ft. shoulders is dangerous on this high speed road (left). For a high-speed road the building at the right is too close to the pavement; it should be set back and the shoulders should be widened on both sides.

THE VIEW of vehicles entering this high speed road is obstructed by the earth bank; it should be removed to open the view, and the material so obtained should be used to widen narrow shoulders on embankments adjoining the cut; a wider right-of-way is needed.



ROAD PROFILES fitted into the landscape aid operation also by providing wide shoulders for animal traffic and gentle slopes where vegetation will grow and hold the ground from wash.

Shoulders should be surfaced with some low-cost material. In Wisconsin, gravel and crushed limestone have been used with good success. Another material which is cheap in localities where it occurs, and is very satisfactory on the shoulder, is shale, and the same is true of disintegrated granite, another low-cost material which is even better than shale.

The separation strip in divided pavements can scarcely be called a shoulder; yet it has an operating function in addition to forming a division. All divided pavements, obviously, must carry a large volume of traffic, much of which will be traveling at high speeds. Crossing such a road at an unregulated crossing is especially dangerous. The dividing strip should be wide enough to enable vehicles to stop in safety between the opposing traffic lanes, which will require at least 30 ft. Such a width is also desirable for proper landscaping purposes.

The purpose of the slope outside of the shoulder is to retain the embankment. Statements have been made that the shoulder slopes should be so flat that vehicles unable to stay on top of the road and between the shoulders would be able to run into the ditches and out again without damage. This writer believes that roads should be so built, that traffic will be able to stay on top of the roadbed without difficulty. However, slopes into the ditches should be gradual. The standard should be a slope which will permit a good clean job of machine mowing of the good grass which should grow on the shoulders, and on the bottom of the adjacent watercourse. It is true that in some places there will be live streams of running water along roads, but the channels which carry surface water along roads should be wide and shallow, so that the water will flow at a slow speed. The ordinary ditch is an abomination. Good grass growing on gentle slopes and in wide shallow channels can be mowed with machinery and the roadside thus kept neat without trouble. Indeed the farmer who owns the fee title will cut it for hay, and thus spare the expense to the public. Back slopes should also be such as will permit good vegetation.

Ten years ago highway landscaping was so little understood, that the only argument urged in its favor was based on aesthetic considerations. Today we realize that proper landscaping is an

LAND BEING WORKED right up to the embankments keeps the roadside neat and clean and free from weeds.

absolute necessity if the road is to provide the greatest utility. Aesthetic considerations are not to be minimized, and they certainly need not be subordinated in a plan of development which will result in the roadside becoming covered with useful vegetation, which will prevent erosion, choke out the noxious weeds which find the ordinary roadside such favorable breeding grounds for the infection of the entire country side, afford a suitable refuge for birds which help to keep down insect pests, and prevent the lodging of snow drifts on the roadbed where they will be unusual impediments to traffic and have to be plowed away at public expense much greater than if the snow were not drifted. In addition to all of these useful functions, proper landscaping will make every roadside a thing of beauty which will be a source of satisfaction to every traveler, an inspiration and joy.

No attempt will be made in this article to enter into the details of how this should be done, except to say that all rural highway landscaping should have as its aesthetic purpose the conversion of the road into an integral part of the landscape. This should be accomplished in such a way, that the roadside inside the toe of the backslope can be inexpensively maintained with machinery, and the roadside outside will tend to grow up in non-noxious native trees and shrubs. There is abundant evidence that this consummation will inevitably result if the proper consideration to the subject is given in the original plans. Some years will be needed, but this affords time for proper consideration.

To attain such an objective means control of the land along the roadside. When a construction project is undertaken, all considerations affecting traffic should be considered, taking into account the population to be served and its industries; considering the population and industry as it is at the time of building, and as it is likely to become in the light of the best available population forecasts. The grading should be such that future needs can be met simply by adding new capacity to that originally built into the road, and without tearing out the landscaping, whose full beauty is not attained until twenty or more years after its first planting. This takes right-of-way of adequate width; in gently rolling country, 100 ft. will generally do with some squeezing; 120 ft. is better; 150 ft. is moderately comfortable; 200 ft. not too much. Even though land is bought for highway right-of-way, the fee title remains with the owner in most states; what the public has is the right of passage, and the right to do what is necessary to facilitate passage.

Arable land within the right-of-way can lawfully be worked by the owner if this does not interfere with the highway, and in such case it is better that it be so worked. If a thicket is planted 100 ft. from the road to control a snowdrift, there is no reason why the land between it and the road should not be worked. Control is needed, however, to prevent developments that will interfere with the proper expansion of the highway. This may be brought about by the enactment of setback ordinances, which will keep building developments outside of the space to be required by the future development of the highway. This procedure is practicable and effective; all that is needed is proper enabling legislation, and an enlightened public opinion which will understand what is needed for proper highway development, and will insist on having it. Though the greatest attention in highway matters is generally centered on pavements, pavements are temporary. The grading is far more important, than the pavement. But more important than either the pavement or the grading is an adequate right-of-way, properly located.

Roadside Improvement Becoming Popular

IMPROVEMENT of roadsides by landscape grading, seeding, sodding, and planting has become increasingly popular in recent years. Since 1933 it has been required that each state include roadside improvement projects in its program of work to be done with federal funds administered by the U. S. Bureau of Public Roads. The total program—completed, under improvement, and planned—includes 1,391 sections of road improved according to plans prepared by landscape specialists. Roadsides have been, or are being, improved on approximately 5,000 miles of highway at a cost of more than $7,000,000, of which the federal government is contributing more than $6,000,000.

Most of these improvements are on main arteries of travel at the approaches to the more important centers of population, and much of the work has been done along existing surfaced highways.

Several features of roadside improvement work that have come to the attention of highway engineers as a result of the object-lesson demonstrations have been adopted in regular highway construction practice in several of the states. Among the practices adopted are flatter grading of slopes and slope rounding, reduction in the depth of ditches, elimination of roadside borrow pits, better cleanup after construction is completed, the saving of trees and other volunteer growth, the conservation of topsoil humus where feasible for later use in ground cover protection, the planting of natural snow barriers, and the construction of small parking areas at scenic outlooks.

Better Appearance Sought In Steel Surge Tank

Design of tank and tower on Platte Valley power and irrigation project in Nebraska departs from the strictly utilitarian in using a special column and balcony railing design.

SURGE TANK on penstock of the Sutherland project in Nebraska which is given a distinctive appearance by open-web columns, a simple balcony railing and ornamental tank ribs.

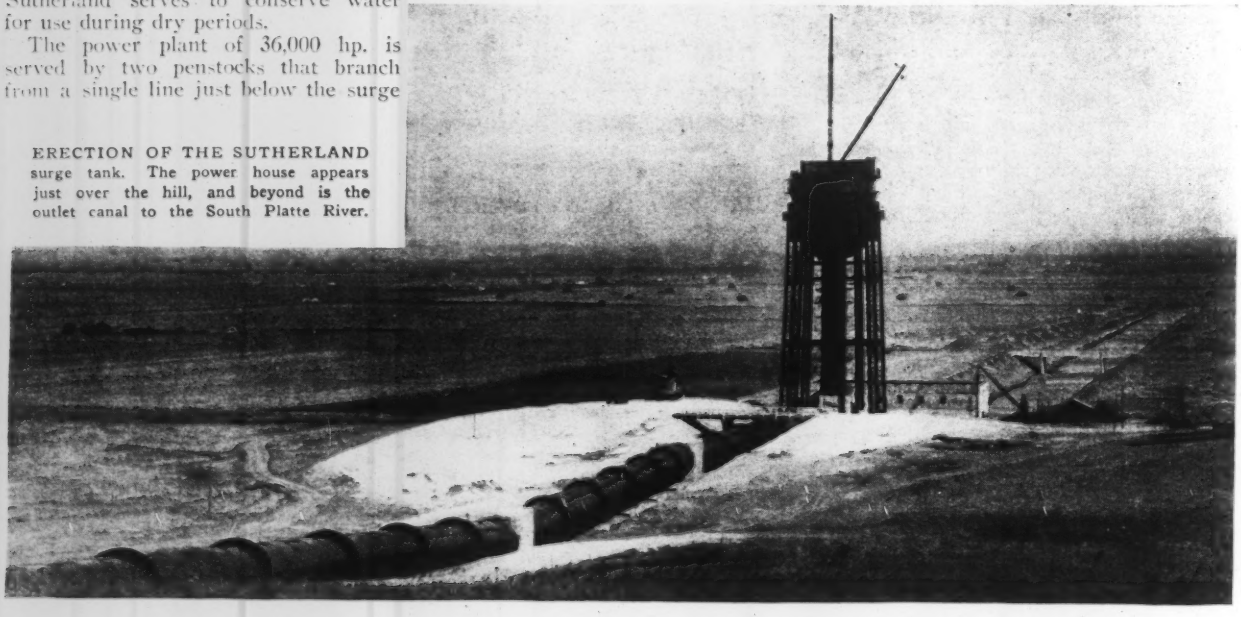
THE ATTEMPT begun several years ago to improve the appearance of elevated tanks used for city water supplies has recently been extended to power plant surge tanks. One of the first surge tanks so treated is that of the Platte Valley Public Power & Irrigation District in southwest Nebraska, the principal departures from the conventional being made in the tower columns and in the balcony railing while the tank proper is given a distinctive treatment by vertical ribs suggesting extensions of the columns.

The Platte Valley or Sutherland project, to give it its popular name, (*ENR*, Oct. 11, 1934, p. 469) takes water from the North Platte River near the town of Keystone, Neb., transports it eastward in a canal about 50 miles long to a power plant from which it is discharged into the South Platte River near the town of North Platte. A few miles downstream the South and North Platte Rivers, which run parallel a few miles apart throughout the length of the canal, converge to form the Platte River. The water discharged through the power house will be used by existing irrigation districts below the town of North Platte. A 146,000 acre-ft. reservoir on the power canal near the town of Sutherland serves to conserve water for use during dry periods.

The power plant of 36,000 hp. is served by two penstocks that branch from a single line just below the surge tank; the single penstock is fed from a forebay about 200 ft. above the power house and three-quarters of a mile south of it.

The surge tank is of the differential type in which there is an internal riser equipped with restricted ports near its bottom, to govern the flow of water between the penstock and the tank. This riser, 11 ft. in diameter, extends from the top of the tank capacity down through the body of the tank and into the external riser for a distance of 4 ft.; the restricted ports are in this 4-ft. section. The external riser extending about 90 ft. from a tee in the penstock line up to the bottom of the tank is 13 ft. in diameter. The tank, of hemispherical bottom type, has a nominal capacity of 910,000 gal., is 46 ft. in diameter, and 57½ ft. high from the spring line to the high water line. The high water line is 166 ft. above the foundations, and the structure is 175 ft. high overall.

The principal distinguishing characteristic of the installation results from the design adopted for the eight tower columns which are built-up members of considerable radial depth, to give the structure a sturdy appearance. The flanges of these columns are built up channel sections, each flange consisting of two 6x4x½-in. angles and one 24x½-in. plate. The two flanges are joined by double lacing of 2½x2½x¼-in. angles attached along the center line of the cover plates by pairs of 3½x3½x½-in. angles. Column panel lengths, of which there are three, vary from 34 to 39 ft. At mid-height of each column length a



ERECTION OF THE SUTHERLAND surge tank. The power house appears just over the hill, and beyond is the outlet canal to the South Platte River.

horizontal bracing member or diaphragm built up of angles and plates is used between the outer and inner flanges.

At the top and bottom of each column section the lacing is replaced by a solid plate. The columns are connected at each panel division by struts, each of which is made up of two 12-in. 20.7-lb. channels with double lacing of $2\frac{1}{2}$x$2\frac{1}{2}$x$\frac{1}{4}$-in. angles. Two sets of diagonal bracing rods are used in each panel, one set for the outer flanges and one set for the inner flanges of the columns. Radial 12-in. channels at each panel point brace the columns against the external riser pipe. The result is a tower of open yet sturdy design quite different in appearance from the usual installation.

On the theory of giving closer integration between the tower and tank, ornamental ribs, appearing to be extensions of the outer flanges of the columns, are carried up the side of the tank shell and over the roof which is relatively flat. The ribs are built-up I-sections of riveted construction and with the stem welded to the tank shell.

A final architectural element is embodied in the balcony hand rail which is executed in a plain design of horizontal bands that expresses the ring-girder function of the balcony.

The tank was designed and built by the Chicago Bridge & Iron Works. Donald D. Price is chief engineer of the Platte Valley Power & Irrigation District and Parsons, Klapp, Brinckerhoff & Douglas, New York, are consulting engineers with E. Halmos as resident representative.

Road Oil and Asphalt Congress

Proposed research in bituminous highway materials endorsed at fifth annual meeting of producers held at Tulsa Oct. 8-9

By G. E. Everett
Secretary, Western Petroleum Refiners Ass'n, Tulsa, Okla.

THE PROPOSED PROGRAM of field and laboratory research in bituminous highway materials was given added impetus at the Fifth National Road Oil and Asphalt Congress held in Tulsa, Okla., Oct. 8 and 9. The Congress, sponsored by the producers of asphalts and road oils in the Mid-Continent field, through the Western Petroleum Refiners Association, went on record as favoring the program and endorsing the action of the Montana Conference in September which directed the state highway departments to seek the cooperation of the producers in financing a program to be coordinated under the Highway Research Bureau (*ENR* Sept. 17, 1936, p. 411).

The sense of the resolutions adopted at both the Tulsa Congress and the Montana Conference is that: "State highway departments shall contact the producers of bituminous paving materials, seeking the producers' financial support, either individually or through the trade organizations, for the proposed activities of the Highway Research Board, in proportion to sales of asphaltic products for highway purposes."

Thus there has developed in the last month a strong support for the program both among the producers, as represented by the Tulsa Congress and among the consumers, as represented by the Montana Conference. The need for research which would develop a series of service tests to determine the durability and lasting qualities of asphaltic construction has been recognized and the action of the two conferences is considered the most important steps taken in assuring the adequate financing of the program.

There is no thought of discarding present tests of ductility, penetration, softening point or other characteristics called for in present specifications. Nor is there any thought of establishing "trick specifications" which can be met by only a few producers. The desire is to determine, by a series of tests in the laboratory and in the field, the most successful types and combinations of asphalt and aggregates and to establish, if possible, formulae for their use under varying conditions.

It is planned that the actual field and laboratory work will be done by the present forces of the highway departments and the oil companies, and the results correlated by the Highway Research Board and made available to producers and consumers for further joint action.

Both the Tulsa Congress and the Montana Conference were noteworthy for the cooperation between those who produce and those who consume bituminous materials. Criticisms were made on both sides but always in a constructive manner and accepted in the same manner.

Chief critic of the producers at the Tulsa Congress was H. S. Gillette, materials engineer, Bureau of Public Roads, who warned that a few producers, either through ignorance of their product or from deliberate intent, foster the use of materials with unsatisfactory performance records. These few, and the engineers who permit themselves to be misled by their salesmen, make it increasingly difficult for the asphalt materials to find the acceptance to which they are entitled. "Looking onto the future," he said, "we find that, insofar as the destinies of asphalt highway construction depends upon the engineers themselves, many things should be done. But above all, many things should not be done. And the first of these things that engineers should not do is to let themselves be too strongly impressed by the artful suggestions of a loquacious fringe of backstair salesmen as to what is a satisfactory asphalt or substantial asphalt construction practice."

Mr. Gillette spoke of the need for a clearing house of scientific information on asphalt in which producers, engineers and the public might be shown the strengths as well as the weaknesses of asphaltic materials and whose recommendations could be accepted by all concerned with no fear of prejudice.

Leroy M. Law, chief chemist of the Shell Petroleum Corp., delivered an excellent paper devoted to the historical development of asphalt from the days of the ancient Egyptians to the present, with a discussion of refining and processing methods. He reported a notable decline in Mexican production in recent years and the development of vast deposits around Lake Maracaibo in Venezuela. Furthermore, recent advances in refining practices now make it possible to extract asphalt from many domestic crude oils that were formerly considered unsuited to the purpose. There are, therefore, no indications of any shortage in asphaltic materials for our future road building programs.

Bituminous highway practices in Kansas, Missouri, Arkansas and Montana were described in detail by L. L. Marsh, assistant maintenance engineer of Kansas, R. C. Shappler, geologist of Missouri, Fred G. Allison, chief chemist of Arkansas and E. B. Donohue, assistant chief engineer of Montana.

The practices, differing somewhat in detail, were similar in the demand for a good base and subgrade support for bituminous surfaces. They were also similar in that the trend is away from use of the earth penetration types of construction, except for temporary use. Missouri's development of an apparently satisfactory and economical base through the process of sub-surface oiling was described and illustrated by motion pictures. Mr. Allison's paper, devoted chiefly to the action of aggregate particles within the mat was a distinct contribution to the bibliography of bituminous construction.

Another paper devoted to the construction of strong and stable bases and subgrade for bituminous surfaces was presented by Brant Holme, chief road engineer of the Morton Salt Co. The stability of the base, he said, can be measurably improved by the addition of proper quantities of salt of right quality. The presence of salt also adds to the

cohesive properties of the mat, he stated.

Mr. Donohue, in addition to his outline of Montana bituminous practice, reported on the Montana Conference held in Glacier Park last month, and extended an invitation to all the Congress delegates to attend the 1937 Conference, scheduled to be held in Yellowstone Park.

Dr. Sidney Born, director of petroleum research, University of Tulsa, spoke in detail of the need for research and suggested some specific problems requiring immediate attention. He urged the Congress to sponsor a research program. Research, he declared, can develop bituminous type roads that will adequately reflect light, that will be skid proof, that will be resilient to traffic and practically noiseless. An important point is to make an investigation into the factors that have caused failures as well as the factors that have contributed to the successful building of roads. A research program should not be limited to bituminous materials, but should cover all associated materials used in the construction of highways.

Laboratory tests, Dr. Born declared, are not sufficient in themselves, but must be coordinated with detailed data concerning the construction of the road, traffic considerations, time, and the influence of the elements on the materials used. He further stated that the present physical laboratory tests of asphaltic road materials are not entirely satisfactory because they do not give sufficient information as to the service characteristics of the materials. He cited the development of a stabilizing testing machine by the California department as an example of the needed extension of bituminous materials research. The experiments made by the South Carolina department of highways with asphalt-impregnated cotton sheeting to prevent surface breaks and to reduce edge failures caused by erosion were mentioned as further examples of desired research.

Although the two days preceding the Tulsa Congress witnessed the heaviest rainfall in years the Congress was well attended, and plans for the Sixth Congress to be held by the Refiners Association about the same time next year were announced.

Structural Alloys and River Control Discussed at Pittsburgh—I

Fall meeting of American Society of Civil Engineers occupied mainly with symposiums on modern structural metals, floods and correction of stream pollution—Power, highway traffic and state control networks also represented

DISCARDING traditions of long standing the American Society of Civil Engineers in its fall meeting at Pittsburgh, Oct. 13-16, extended its technical sessions from the customary two days to three, with as many as four divisional meetings going on at once. The program was of remarkable breadth and fullness, due in large part to the preparatory work of the local committee headed by A. V. Karpov. The principal subjects were discussed by groups of interrelated papers in symposium form. Most elaborate of these was a symposium on structural application of steel and lightweight alloys. The papers in this symposium were laid before the meeting in the shape of a printed volume, also the work of the local committee. Of even greater local interest was a group of sessions on flood control with special reference to the upper Ohio, and on the problem of controlling the pollution of this river. On account of space limitations the papers on the structural, highway and city planning subjects will comprise Part II of this report to be published next week.

Flood control

Because of the disastrous flood of March 17, 1936, in the Allegheny, Monongahela and Ohio rivers at Pittsburgh, with a rise to unprecedented stage of 46 ft., and the complete failure of the flood forecasting service, and also because of the subsequent enactment of the Omnibus Flood-Control Act by Congress in which the policy of national responsibility for controlling floods in navigable rivers was adopted, the flood sessions engaged intense interest.

An opening statement on the March flood visitation in the northeastern states and governmental responsibility therefor was made by Senator James J. Davis. Following this, important fundamentals to a national flood protection policy were laid down in a paper by Abel Wolman, chairman of the federal Water Resources Committee. "Few flood protection programs should proceed in the United States without consideration of the relationship of their methods to other possible uses of the water," said Mr. Wolman, emphasizing at the same time that engineers as well as laymen are guilty of violating this principle. A second fundamental cited is that "slow motion (particularly in adopting financial programs) is the proper mode of advance and that heroic action is dangerous." Trial and error methods must be accepted in dealing with water conservation and control.

Formulation of any program must consider its engineering, financial and administrative aspects, pointed out Mr. Wolman. From an engineering point of view, absence of basic hydrologic data is most compelling; the public needs to be convinced of the necessity for funds to remedy this lack. Only slightly less important is the necessity for engineers to do more in the way of objective analysis and less in provincial and partisan promotion of schemes for flood control. The financial aspect is even more difficult to evaluate, principally because the respective roles of the federal, state and local governments are not defined. And while a logical national policy could perhaps be drawn up, there is a distinct danger of its degenerating into a universal grab-bag for distributing federal funds to local projects. Experimentation with various financing methods seems to Mr. Wolman to constitute the present proper course of action.

Operation of control devices

Problems of operation of flood protection devices are as compelling as the engineering or financial aspects of their design. Unless an engineer, for example, has full authority to drain a reservoir to prepare for a flood period, the proper use of the reservoir is curtailed. Discussion on this point was contributed by E. H. Sargent of the Hudson River Regulating District whose Sacandaga Reservoir held back enough water in the March floods to

reduce appreciably the gage height at Albany. Mr. Sargent said he had complete authority to empty the reservoir whenever in his opinion it seemed desirable. The reservoir is owned by a group of power companies downstream.

Turning to another phase of the problem—the economic aspect of floods—Nathan B. Jacobs, president, Morris Knowles Inc., consulting engineers, Pittsburgh, described the various ways in which existing protection works have been financed. They are seen to be so diverse that no conclusion can be drawn from them as to a course of action in allocating costs to the several benefited agencies. One recent development is a recognition of federal responsibility where life or social security are endangered. Property damage is probably a local concern, and presents a serious question because homes and industries insist on locating in areas subjected to floods. Mr. Jacobs concludes that detention reservoirs of the multi-service type offer the best possibility of effective flood control and the best chance for spreading costs equitably.

Flood events and causes

Factual reviews of the New England flood by W. F. Uhl, hydraulic engineer, Boston, and Capt. H. J. Casey, of the U. S. Engineer Corps, and of the New York state floods by A. W. Harrington and H. Johnson of the U. S. Geological Survey, and Col. E. L. Daley of the Engineer Corps, opened the second session of the flood symposium. The papers brought out definitely the unprecedented stage heights and discharges, the abnormal intensity of the rainfall, and the fact that at the peak many rivers had greater discharge per sq. mi. than ever before recorded in that part of the United States.

Harrington and Johnson, covering both the remarkable summer flood of July, 1935, and the March, 1936, flood in central New York, reported that on July 7 to 8, 1935, the rainfall was officially reported as reaching a maximum of 10.5 in. in 24 hr. at Burdette, but that unofficial reports from other points indicated maxima of 12 to 16 in. in as many hours. This storm also had an east to west axis, cutting across several small drainage basins, and might have been far more destructive if by chance it had been concentrated in one basin. Peak discharges in the small streams of the south-central part of the state were incredibly high, up to 2,000 sec.-ft. per sq. mi. Even on the larger drainage areas high discharges were recorded; the Chenango, draining 1,492 sq. mi. had a peak discharge of 56 sec.-ft. per sq. mi. Encroachment of village structures on streams, inadequate bridge openings and the like were responsible for great property damage. In contrast the March floods of this year came at a time of snow melting. The effective functioning of the Sacandaga Reservoir on the Hudson River headquarters was duly emphasized; its storage reduced the peak flow at Albany to 165,000 sec.-ft., whereas the discharge in the less intense flood of March, 1913, was 225,000 sec.-ft.

Because the New York area was visited by two serious floods in nine months, after having been spared flood damage for over a quarter of a century, the population is particularly interested in flood-control measures. The authors pointed out the need of expert guidance, so that uneconomic programs will not be started. Recognizing that storage is the backbone of successful flood control operations, the authors stress the fact that large reservoirs require natural sites which are often non-existent and that a series of smaller reservoirs therefore must be used; the public needs education in these matters. It is also necessary to impress upon the public the desirability of clearing many man-made structures out of the flood plains. More precipitation stations and more stream gaging stations are needed.

In discussion of New England floods Captain Casey, reemphasized the remarkable intensity of the floods of March, 1936. "Discharges and gage heights on many of the rivers exceeded by unbelievable amounts any previous ones of record." On the Connecticut the 150-year record was exceeded by a peak discharge one-third greater; on the Merrimack a 90-year peak record was exceeded by 70 per cent; on the Saco the peak of 30 years was more than doubled; on the Androscoggin the peak was almost 40 per cent beyond the prior record. On the strength of these figures Captain Casey asserted that the maximum probable discharge for flood-control planning cannot be obtained from records but "only by a study of the possible combination resulting from the maximum snow cover coupled with a severe storm or two recurring storms of the maximum intensity which can prevail in that general area in the spring flood."

Reservoir storage

On the subject of reservoir storage, Captain Casey stated that in many instances it is too costly, especially under New England conditions, and a combination of control measures is usually best. In respect to storage it must also be remembered that uncontrolled power development through the entire reach of a river may increase and advance the flood peaks.

The following formula for flood-control storage estimates was proposed by Captain Casey: Sq. mi. of drainage area multiplied by 160 to give total acre-ft. of flood storage required (representing 50 per cent control of a 6-in. runoff); this storage multiplied by $25 to $50 for cheap to moderate cost reservoirs will give the storage construction cost.

Flood forecasting breaks down

In a pointed review of the events of the flood week in March at Pittsburgh, E. K. Morse, consulting engineer, cited the incorrect and misleading forecasts of flood stages issued by the Weather Bureau and pointed out that many millions of dollars of damage could have been saved had the forecasts been more nearly correct. Further, he showed that far greater flood heights might have been reached and may be reached in future, had the rainfall been distributed in a slightly different way or had the heavy ice in the rivers held until the middle of March instead of going out in an earlier freshet, Feb. 28. He regards flood heights in excess of 50 ft. at Pittsburgh quite possible, and declared that such a flood if carrying the full ice load would destroy all downtown Pittsburgh.

Speaking of the effect of the Pymatuning Reservoir in reducing floods in the Chenango and Beaver valleys, he said that it saved the manufacturers of the valley the full cost of the taxpayers' investment in the reservoir.

Prof. H. A. Thomas, Carnegie Institute of Technology, Pittsburgh, set forth the history of flood protective studies and efforts of Pittsburgh, beginning with the organization of a civic flood commission after the 1907 flood. The 45 reservoirs studied by this commission were reduced to 17 in its 1912 report; flood walls were to provide auxiliary protection. Industrial and railroad occupation of the valleys was recognized as a major obstacle even then. Later the problem was the subject of several successive studies by the engineers of the U. S. Engineer Corps, whose recommendations reduced the number of reservoirs to 11, discarding those of "inferior storage" capacity (less than 5 in. runoff from drainage area above); some of the flood commission reservoirs could hold only 2 in. runoff depth.

The final report of the Army Engineers, for 11 reservoirs with twice the storage capacity of the original 17 and much higher dams, was estimated to cost $97,000,000, which exceeded the capitalized value of the flood damage. A subsequent review showed that further reduction in the number of reservoirs would make it possible to prevent 87 per cent of the damage by a $58,000,000 project. A project substantially in accord with the Engineer Corps plan was authorized by Congress last summer through the Omnibus Flood Control Act, under which local interests are required to cover one-half the cost. No arrangement for this local contribution has yet been made.

Speaking for the Weather Bureau, M. W. Hayes, chief of the river and flood division, Washington, disclaimed responsibility on the part of the Bureau for failure to forecast the flood stages correctly. Wires were down and the essential information was not obtained from up-river points, so that the forecasts could only be blind. Pittsburgh cannot be held entirely blameless, particularly because no local effort was ever made to obtain increased appropriation for flood forecasting work.

Reviewing the development of flood forecasting from the earliest work in France in 1854, Mr. Hayes laid down the essentials of forecasting and the type of organization needed. The work cannot successfully be combined with weather observing, in his opinion, but requires a separate group of men both for the field work and for the study of flow formulas. Such a plan was set up more than a year ago and a beginning has been made toward carrying it out by placing staffs in the upper Missouri and the upper Mississippi river basins. The full plan, however, must cover 64 separate flood forecasting centers, and it will probably prove impossible to provide a hydrologic specialist in each of these centers.

Protection for Pittsburgh

Turning specifically to Pittsburgh flood protection plans Lt.-Col. W. E. R. Covell, U. S. District Engineer at Pittsburgh, reported on the present status of the work. The approved project comprises 10 reservoirs including the Tygart Valley reservoir now under construction, and nine additional ones, (on French Creek, Tionesta Creek, Redbank Creek, Mahoning Creek, Crooked Creek, Conemaugh River, Loyalhanna Creek and the West Fork of the Monongahela River). These would control about 7,500 sq. mi. directly, or about one-third of the drainage area above Pittsburgh. Local interests must furnish right-of-way, hold the government blameless as to damages, and undertake to maintain, but are limited to one-half the total cost. Pennsylvania has passed all necessary legislation and contributed $200,000, so that construction can start as soon as the sites are finally decided upon and the land is secured. West Virginia still must enact legislation and the city of Clarksburg protests construction of a dam above the city on West Fork because of the fear that it may reduce the city's business. The lands in New York state in the Allegheny River reservoir areas will have to be paid for by Pennsylvania.

Parties are in the field surveying all dam sites and getting borings, and work will soon begin probably with Tionesta Creek, Crooked Creek and Redbank Creek reservoirs, first followed by the main Allegheny River dam above Morgan and the French Creek dam. Supplementing the approved project, the President allocated $300,000 of relief funds for a dam above Johnstown.

Gen. George B. Pillsbury, Assistant Chief of Engineers, U. S. Engineer Corps, Washington, set forth the present attitude and activities of the War Department in relation to floods. He referred to serious flood hazards that threaten many cities, notable cases being Pittsburgh, Kansas City and Los Angeles. Because of the new policy established by the Omnibus Flood Control Act, which declares floods on navigable streams to be a matter of general welfare and therefore a national responsibility, a vast field of study of flood probabilities and flood-control projects has been opened up. Gen. Pillsbury pointed to the fact that flood control dams differ from most other engineering works in that it is not permissible to take any chances, since the destruction resulting from failure or inadequacy of the dam would be far greater than the damage it is sought to prevent.

T. T. Knappen stated that experience indicates that flood hazards are often lost sight of in industrial and community development and that industries are often willing to gamble against the flood hazard. Apart from these difficulties however flood control engineering is as yet only in its early stages. One of its elements, economic study, must extend beyond estimation of damage and include the effect of protective works to hinder or promote the economic development of the region immediately affected.

Stream pollution

Opening a far-ranging symposium on stream pollution with a general discussion of feasible lines of action, Abel Wolman, chief engineer, Maryland health department referred to the great variability in pollution content, the inapplicability of uniform standards or rules, and the relative ineffectiveness to date of legislative measures as well as the unevenness of the advances made in different states because of differences in initiative and enthusiasm. These factors together with lack of knowledge of the solution of many trade-waste problems, make the correction of stream pollution a highly complex undertaking. The key, however, is money, and this has been found difficult to raise for the purpose in question. Federal grants in aid have proved a highly effective device, as shown by the fact that more than 25 per cent of all sewage treatment plants in the United States were built in the past three years under federal assistance. Extension of the aid principle therefore contains promise. Points requiring consideration in efforts to correct stream pollution are these: that standardization of state laws on the subject is desirable but probably of limited value; that greater interest in the problem on the part of industry is important; that stimulation by state or federal aid offers promise but should be dealt with cautiously; and that the ultimate solution will be found in close cooperation between public official, private investor and the man in the street.

Coming from the general problem of stream pollution to the specific Ohio River problem, E. S. Tisdale, director of sanitary engineering, West Virginia health department, outlined the leading steps in reduction of the river's pollution. In the entire 900 mile length of the river, with its 53 navigation pools covering a vertical range of 413 ft. and with a drainage area above Cairo of more than 200,000 sq. miles, nearly 2 million people obtain their drinking water from the main stream itself, and additional millions from tributaries.

Because nearly all the communities along the river discharge raw sewage into the stream, as well as because of heavy acid and phenol pollution, the use of the river water to produce satisfactory drinking water supply, is difficult. Intestinal disease epidemics developed in some regions in 1934 and 1936. The Ohio River Board of Engineers, a body composed of the engineers of the state health departments concerned with the river, has been at work since its formation in 1924 to ameliorate the pollution conditions. It succeeded in bringing about a great reduction in phenol pollution by cooperative work with the steel industry, which now saves the phenol as a valuable by-product. In 1933 this board prepared a report on reducing acid mine drainage, which served as the basis for the program of sealing abandoned coal mines put into effect in December, 1933 as a CWA project, later taken over by the WPA. In Ohio, the state health department reports, this work reduced acid pollution by 200,000 lb. daily, up to the present time. West Virginia in three years has made a reduction of 383,000 lb. per day, by sealing 3,644 openings, at an average cost (construction plus maintenance) of $105 per opening.

In January 1936 the Ohio Valley Planning Commission was organized by the state planning boards of the five states from Pennsylvania to Indiana. On its initiative Congress, in May of this year, passed a resolution authorizing the drafting of a compact between the states to control stream pollution.

Pollution at Cincinnati

J. E. Root, director of public works, Cincinnati, Ohio, reviewed that city's difficulties in coping with pollution in the Ohio River, difficulties which have been accentuated by the canalization of the stream. Cincinnati's problem, like that of the whole Ohio River basin, is interstate. While Cincinnati would like

to begin definite planning for sewage treatment, it needs the aid of other cities upstream. Mr. Root pointed out that Cincinnati's sewerage program when it does get under way will be very expensive. A report on available plant sites in 1912 reported five available; today one of these is occupied by the union railroad terminal, another by the municipal airport, and a third is 16 miles from the city. The other two are none too large and will require flood protection.

Cincinnati conditions were further discussed by F. M. Waring, chief engineer of the Ohio health department, who emphasized the change in conditions since the report of 1913 which concluded that sewage treatment would not be necessary for a number of years. The Cincinnati water treatment plant when built in 1907 was second to none, but it has never been changed and the river is now much more polluted with its canalization completed, with the result that in recent years the quality of the product has not always been satisfactory, particularly since 1930. The state health department has forcibly pointed out the necessity of complete reconstruction and enlargement of the treatment plant.

An interesting point brought out by Mr. Waring is that 70 per cent of the PWA operations in Ohio, whether calculated in money or in number of projects, involved sanitary improvements.

Pollution at Pittsburgh

Planning for control of stream pollution at Pittsburgh was dealt with by D. E. Davis, consulting engineer, Pittsburgh. Along the 80-mile length of main river (Allegheny, Monongahela and Ohio) in Allegheny county there are 116 separate municipalities, with a sewered population of 1,200,000, most of them discharging raw sewage into the rivers. In addition there is an equal population equivalent contributed by industrial sewage. As a result of this heavy pollution water treatment problems exist far down the river, and it is forecast that soon these will be aggravated to the point of making it impossible to produce a safe water supply. An element of the pollution is some 9000 tons equivalent of pure sulphuric acid daily passing Pittsburgh. While this renders treatment difficult, it is an advantage in delaying putrefaction of the organic matter in the water, and were the acid to be completely eliminated it is apprehended that serious nuisances would develop in the rivers at Pittsburgh.

In 1910 the state health department ordered Pittsburgh to report a plan for dealing with sewage pollution, which the city did in 1912. The United States Public Health Service made an elaborate report on the river in 1916, and 15 years later completed a further study in cooperation with the several states. In 1933 the State Health Department again urged the city to study sewage disposal, and as a result of this initiative the metropolitan drainage survey was instituted, surveying the county area by individual drainage basins and selecting sites for primary treatment plants. Its studies show that not more than 36 individual treatment plants at the mouths of the several drainage basins will suffice to provide for the sewage discharged into the river, at a cost of less than $20,000,000. Sites for secondary plants, each to deal with a group of primary plants at some later time, are also under consideration.

Referring to control of industrial wastes, Mr. Davis commended the Lonergan and Barclay bills before Congress to "empower policing of recalcitrant industries."

Important supplementary information was presented by L. S. Morgan, of the Pennsylvania department of health, who gave the results of a series of river analyses at a number of points near Pittsburgh during a wide range in river flows. He found no oxygen shortage. The coli index was high at high flows and low at low flows, which may be attributed to the fact that the effect of the acid in the water is greatest at low flows.

H. W. Streeter, of the U. S. Public Health Service, reported the results of calculations of equivalent volutions of population at several points along the length of the Ohio, carried out by stepping down the actual tributary populations by a previously determined rate of self-purification. Calculations made for flow without allowance for acid content showed that the latter figures check closely with actual B coli averages.

Legislative control

Control of pollution at Pittsburgh can be accomplished only by legislative fiat, according to Henry D. Johnson, Jr., chief engineer of public works, Pittsburgh. Action by the 116 municipalities in the Pittsburgh district can be assured only by one of two methods initiated by the state legislature: either to adopt a plan and require all of the communities to adhere to it or else to establish a sanitary district which would plan and carry out the improvements for the whole region involved with autonomous financing like that of the Chicago Sanitary District.

The present urgency of the Pittsburgh pollution problem as the result of the reduction of acid by mine-sealing and therefore removal of a check to sewage decomposition, together with a sharp increase in evidences of pollution at Pittsburgh since 1913, makes progress toward sewage treatment urgent, said C. M. Reppert, former chief engineer of public works, Pittsburgh. While present installations may properly be limited to primary treatment, the progressive change in conditions makes it necessary to provide at once for future secondary treatment.

D. E. Davis of Pittsburgh, in further discussion of acid effect on pollution raised the question of whether the mine acid contained in the water kills bacteria or merely leaves them in dormant condition; also whether other water organisms and plant growths have a part in reducing the organic load. From the figures so far presented he concluded that acid reduction will make the pollution conditions at some points of the river very grave, so that it becomes a question whether the mine-sealing program now in progress should be limited.

All-purpose control

Speaking of the general problem of dealing with stream pollution, F. E. Schmitt, editor of *Engineering News-Record*, pointed out that stream improvement or control with respect to pollution, is interrelated with stream control or development for flood protection or other purposes, and that it is much to be desired that all purposes receive consideration rather than one. The administrative problems suitable to such development are being worked out only slowly. That which is being developed by the Tennessee Valley Authority is the most interesting, but may not be applicable elsewhere. The method being applied to the Ohio will if successful show a way to accomplish the objective of pollution control without primary dependence on federal initiative.

Harrison P. Eddy, consulting engineer, Boston, emphasized the importance of public health as an argument for reduction of stream pollution, an argument that he characterized as more compelling than reasons of convenience or decency. Further public education is vital to making these reasons of fullest effect, a view that was supported also by Prof. E. D. Walker of Pennsylvania State College.

Pymatuning Reservoir effect

Increase in low water flow, a matter directly bearing on degree of pollution, was dealt with by Charles E. Ryder, chief engineer of the Pennsylvania Water and Power Resources Board, in discussing plans for operating Pymatuning reservoir on the headwaters of the Chenango River about 90 miles north of Pittsburgh, to serve flood control, public water supplies, industrial water supplies, sewage dilution, and recreation requirements on the reservoir itself. The dam was completed in 1934, so that about a year's operating results are available.

Studies indicate that the diverse demands made on the reservoir can be met satisfactorily. Thus, for effective flood control it is indicated that 2 ft. of storage above the spillway will hold back

floodwaters from a storm equal in intensity of that of March 1913, the highest on record. Accordingly a 2-ft. weir is being placed on the spillway, which will be closed for flood control. At other times the level of the reservoir will be held at or slightly below spillway level. The resulting storage will reduce flood heights at Sharon by 2½ to 3 ft. The 2 ft. fluctuation of reservoir surface will also take care of dry weather flow demands and of water supply requirements from the stream and at the same time will not hinder use of the reservoir for recreation.

Emergency sanitary operations to take care of health conditions during floods were set forth in considerable detail by W. L. Stevenson, chief engineer of the Pennsylvania Department of Health. Mr. Stevenson's most important conclusion was that the public should insist on preparing now for adequate sanitation in the next flood.

Robert Spurr Weston, consulting engineer, Boston, who discussed emergency sanitation, also made the more general point that flood control should always be harmonized with health requirements (those of water supply and sewage disposal), and that for this reason flood-control plans should always be submitted to health authorities for approval before adoption.

Plane-coordinate survey control

A lively discussion following Dr. O. S. Adams' address entitled "Statewide Systems of Plane Coordinates," marked the high point of an enthusiastic meeting of the surveying and mapping division. Dr. Adams explained the features of these systems, and the methods he employed in the computation of them, and pointed out that by using plane coordinates to express geodetic positions, the triangulation net of the U. S. Coast and Geodetic Survey can be used for the control and correlation of surveys by performing only the usual plane computations.

Prof. Philip Kissam, Princeton University, spoke in favor of state systems pointing out that in New Jersey not only is the system in constant use but many government agencies and private enterprises have taken advantage of the law legalizing the system to describe their properties by these coordinates for permanent identification.

Prof. E. F. Coddington, Ohio State University, opposed the introduction of the state systems. He advocated individual spherical systems for counties and for individual projects, stressing the inability of the average surveyor to make surveys accurate enough to be of use in re-determining property corners from a control system.

L. E. Yoder, Consolidation Coal Co., Fairmont, W. Va., explained the commercial application of plane coordinates and demonstrated that with ordinary instruments it is possible to establish a plane coordinate system. He said that "without such a system, a large mining company cannot be property operated."

The debate continued considerably beyond the time limit set for the meeting. An opponent of the system said that he "could see no advantage in attempting to locate property from monuments spaced at 4-mi. intervals."

Prof. Kissam suggested that in order to make a permanent advance in the simplification of title surveys, a Land Court might be established empowered to confirm and register title after a survey and title search under the direction of the court and with the legal stipulation that no claims of adverse possession be permitted nor liens be allowed that are not registered with the court. George R. Copeland, of the Pennsylvania Planning Board, explained the importance of the state system to his state and pleaded that the state take steps to establish the necessary control. Prof. A. H. Holt, Iowa State University, announced that a law is being prepared to legalize the system in Iowa and that the U. S. Coast & Geodetic Survey is preparing a model law for other states.

Power economics

In the symposium on economic aspects of energy generation staged by the Engineering Economic and Finance Division and the Power Division a group of five papers were presented covering both technical and social aspects. In the first paper George A. Orrok, consulting engineer, New York City, outlined progress in the generation of energy by heat engines. The total annual per-capita use is 2,300 kw.-hr. of which nearly half is central station plus industrial. Central station generation requires 1.45 lb. of coal per kw.-hr. and the industrial is twice that, with an average of 2.13 lb. or the equivalent of 104,000,000 tons of coal, which is 20 to 25 per cent of our present coal output. Boiler tests show efficiencies between 82 and 92 per cent. Progress is in two directions; (a) learning how to burn all the fuel at the best condition and (b) adding heat traps to catch all the heat not absorbed by the boiler proper. High pressure and high superheat are modern developments. As a measure of progress, it was noted that at the old Edison station at Pearl St. a 12 per cent load factor was satisfactory while today, system load factors may go as high as 40 per cent with certain industries attaining 70 per cent and higher.

Hydro generation advances

Advances in hydro generation, outlined in a paper by F. H. Rogers, chief engineer, I. P. Morris Division, Baldwin-Southwark Corp., Philadelphia, covered such items as the straight flow nozzle to reduce turbulence in the impulse turbine, leakage seals with soft metal bearings on high head turbine installations, adjustable blade runners, cavitation limitations and reduction through experimental investigations, rubber lined bearings, machined runner blades and automatic adjustable blades. R. M. Riegel, TVA, in discussion said that there was interest in higher head propeller units, and particularly in the design of such accessories as gates, trash racks, governors and penstocks. Joel D. Justin, consulting engineer, Philadelphia, in discussing new methods of utilizing energy, cited air conditioning as an outstanding example.

Hydro power costs

The cost of generating electric energy is only a small part of the total cost of making it available for use said Philip Sporn, vice president and chief engineer, American Gas and Electric Co., New York City. Because this fact is not fully realized much current discussion is out of focus. Hydro power, for example, is not cheap power because of high installation costs and equally high fixed charges.

Mr. Sporn cited some fifteen projects in which the cost per kilowatt of hydro power on an installed capacity basis as varied from $125 to $348. In contrast, steam power costs for some 50 plants varied from $82 to $180. Hydro fixed charges show variations from 0.342c. to 4.56c. per kw.-hr. on a 90 per cent load-factor basis and from 0.38c. to 1.067c. per kw.-hr. on a 40 per cent load-factor basis. Hydro costs are not predictable from general experience and knowledge of the art of generation, but will depend on head, topography, stream flow and location. Hydro power in general as a source of primary power is out of the reach of economic consideration in Mr. Sporn's opinion.

Transmission costs for hydro power rise rapidly after 200 mi. and with decrease of load factors below 50 per cent they approach steam power costs. In other words it is cheaper to transport coal than electricity although the exact balancing point involves local considerations. At any rate distribution cost is the major element in total cost of energy and it varies greatly with customer use and type of construction. Finally, in hydro development there is no trend to lower costs in sight. On the other hand, the art of transmission has been greatly improved during the last 15 years. Other conclusions noted were that stability limits of alternating current transmission lines have been extended and that direct current transmission is still experimental and even though it may be found feasible its economics are unknown.

Part II of this report covering structural alloys, highways and city planning will be published next week.

CURRENT NOTES ON SEWAGE DISPOSAL

An analytical summary of recent developments for the engineer, research worker and plant operator

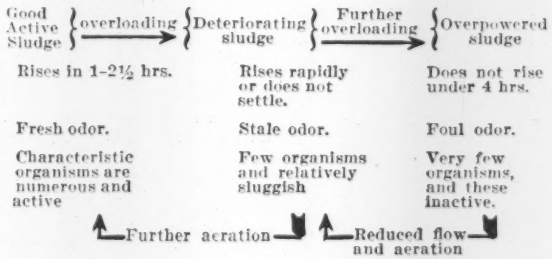
WILLEM RUDOLFS,
Chief, N. J. Sewage Experiment Station, New Brunswick, N. J.

● RISING OF ACTIVATED SLUDGE

The contamination of effluents from final settling tanks by sludge particles may be due to a number of causes such as incomplete clotting, scum formation in the aeration channels, overloading of settling tanks, or "bulking" and rising of the settled sludge mass. It is frequently stated that the "blanket" rising of sludge and subsequent passage over the weirs is due to over-aeration. McLachlan (paper before Institute of Sewage Purification, July, 1936, Exeter, England) states that experience at the Bruma Works, Johannesburg, South Africa, has shown that to produce an over-aerated sludge requires days of aeration rather than a period measured in hours—in other words, a much longer aeration period than could be provided in normal plant operation.

Over-aeration results in the continued breaking down of large flocs until a sludge of fine particle size is produced due to mechanical agitation and the practical completion of biological oxidation of organic matter. Blanket rising is different from true sludge bulking. Bulked sludge may be composed almost entirely of long filamentous growths of characteristic appearance, a very light color, scarcity of bacterial zooglea, small flocs, low total solids and a minimum propensity for settling. A rising sludge, on the other hand, may possess one or two of these characteristics but differs in that it is composed of large, easily settling flocs which may cause the entire sludge mass to come to the surface.

Experimentation has shown that such blanket rising can be produced at will. McLachlan concludes that blanket rising may result from over-powering good reconditioned sludge by the introduction of a stronger sewage than usual. He summarizes the relations of a rising sludge with plant operation briefly as shown below.



The suggestion by O'Shaughnessy that blanket rising is caused by nitrogen gas is accepted. Whatever the origin of the gas in rising sludge, any form of mechanical shock or agitation will serve to liberate the gas bubbles and prevent rising. The author attempted to add electrostatic charges to the sludge particles but indications were not sufficiently promising to justify continuation. The following statement appears to be worth quoting and may be of benefit to both designers and operators. "When surveying our own problems in activated sludge besides those of overseas workers, and in assessing the extent to which the process itself is chargeable with difficulties in operation, the conclusion appears justified that nearly all the failures and trials of activated sludge can be laid at the door of insufficient equipment."

● FILTER MEDIA

Trickling filter treatment of activated sludge effluent has been practiced during the last few years in several plants in England, but comparatively few results have been published. Recently Miller (*The Surveyor*, July 3, 1936) reported upon further purification of effluent from a partial-treatment activated sludge plant effected by trickling filters, in which flint gravel, and gravel topped with roadstone or coke were compared as filter media. Different sizes of these materials were used. Little difference was noticed in the quality of the effluents from the different sizes but the ¾ to 1 in. was preferred because, although ponding took place, the development of film was not as great as on other sizes, and *Psychoda* fly and larvae were less numerous; the springtail (*Archoroutus viaticus*) seemed to prefer the smaller size. The effluent from filters of gravel, or coke topped by gravel, was not uniformly as good as that from the coke filters alone. Results obtained in this country on settled sewage have shown that coke, although just as efficient as broken stone filter media, retained larger volumes of sludge and was subject to clogging and disintegration.

● SLUDGE AND GARBAGE COMPOSTING

After sludge has been digested and dewatered the problem of final disposal is still in hand. Incineration appears to be one way out for large plants. Adding sludge to garbage for disposal in refuse incinerators is another possibility. For many years in France, Holland, India and China mixtures of garbage and sewage sludge have been composted and this procedure has been more or less successful. A new approach to sludge and garbage disposal is reported by Davies (*The Surveyor*, June 26, 1936) who describes the operation of the "Maidenhead Process." Mixed refuse is fed into a rotary screen provided with two meshes by which the grit and ashes are separated from the organic screenings. This latter material is crushed, spread out into beds or bays, and then covered with sludge. Within two days the entire mass is turned over, the temperature meantime having reached about 170 deg. F. Evaporation is intensive and after two turn-overs the mixture is quite dry and subject to aerobic decomposition. The process requiring a total of 14 days, produces a dry, fine compost without weeds, intestinal organisms or odor.

● COPPER SULFATE AND MILK WASTE

Milk wastes have been treated chemically in a number of instances with more or less success but in general, this type of treatment does not appreciably reduce the soluble substances present and consequently the biochemical oxygen demand of the waste remains rather high. A treatment process utilizing copper sulfate is now reported by Damn and Bock (*Molkerei Zeitung* No. 43, 1936). They used about two pounds of copper sulfate per 225-275 cu.ft. of waste and were able to produce a good floc. The flocculated material was then passed through a "Magno-filter" and although the effluent was clean it was still highly putrescible. On account of the copper content in the effluent no B.O.D. determinations could be made. Experiments in composting the precipitated sludge for use as fertilizer on soils requiring copper are now underway. The "Magno" sand filter appears from sketches submitted to be about 3 ft. in thickness and it is backwashed in a manner similarly to that in use at waterworks plants.

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Unexpected Revenue

FROM A COUNT OF VISITORS to Grand Coulee dam, showing a year's total of more than 200,000, Washington state authorities have computed that some $10,000,000 is brought into the state annually by this route. The sightseeing tourist evidently is a substantial though unexpected source of revenue. Bonneville, Boulder Dam and the big bridges at San Francisco are similarly potent attractions to visitors, and their effect on local revenues must also reach large figures. Inasmuch as the advance balance sheets of none of these projects took account of this income item, the final reckoning should show better figures on the credit side than anticipated. It appears that big engineering works increase our national scenic assets sufficiently to show definite profits, and while this cannot excuse undertaking uneconomic projects it does have a bearing on the elusive question of local benefits and distribution of cost of projects justified on other grounds.

Engineers and Public Policy

BY DIRECTING a major part of its program to technical problems that are leading public issues of the day, the Pittsburgh meeting of the American Society of Civil Engineers made a substantial contribution to progress. Perhaps its largest value lay in the discussion of floods and stream pollution and how they may be controlled. These problems are of extraordinary urgency, and in addition to technical difficulties present many unsolved questions of basic policy. It was well said at the meeting that flood-control engineering is hardly beyond its infancy, and the statement might have been supplemented by the remark that the administrative procedure applicable to flood control is even less developed. The same thing is true of stream pollution abatement. It happens that in both fields public policy depends intimately on technical facts and methods. Accordingly the study of policies, if these are to be lasting and sound, must go on hand in hand with technical study. Continuation of the type of discussion initiated at Pittsburgh should therefore prove of distinct public service by clearing the way to progress.

Integral River Treatment

IN SO FAR AS the flood-control act passed by Congress last year laid down a national policy to govern future improvement of rivers, flood control at present is treated as a matter quite unrelated to other river requirements and uses. The events of recent years, however oppose such procedure as undesirable. They have shown that stream control and utilization is in most cases, if not in all, a single problem, of which navigation, floods, power, conservation and pollution are merely individual phases that must be considered jointly. Possible conflict between power development and flood control was pointed out by one of the speakers at Pittsburgh. Even more definite conflict through uncorrelated treatment of river problems was revealed in the harmful effects of Ohio River canalization on the safety of public water supplies drawn from the river. There is evident justice in the National Resources Committee's repeated urging that river problems be treated integrally in order to bring about the best development of river resources. It is to be hoped, therefore, that both water quality control and flood control will not long continue to be handled independently. In leading toward this result the Society's work can be of distinct aid, especially if its discussions are extended beyond the separate compartments of specialists.

Benefits from Forecasting

PARTLY BECAUSE IT WAS SENSATIONALIZED by sharp criticism of the flood forecasting failure at Pittsburgh last March, the demand for better flood forecasts that emerged from the Pittsburgh meeting may be expected to have practical results. The need for a real forecasting service is well enough recognized (at least at those points where extreme flood stages occurred recently) that the necessary funds may be furnished in spite of a general seeking for reduction in government expenditure. It is pertinent to ask, however, whether the value of a truly effective forecasting service is sufficiently appreciated to insure support of a countrywide system. The test is whether Pittsburgh will be willing to pay its share of the forecasting of Connecticut and Colorado River floods and help maintain snow surveys in the West as well as ice and thaw studies in the East. If not, the case for Ohio flood forecasting has not been fully enough established. Yet Gen. Pillsbury's reference to the critical flood hazard of a number of valley cities—he mentioned specifically Pittsburgh, Kansas City and Los Angeles—added force to the argument for an alert and well-staffed river observing organization. Engineers and hydrologists know that many critical flood hazards are ignored, sometimes because chamber-of-commerce fears of adverse publicity keep them from public knowledge but more often because the true facts have not been explored. More active public appreciation of flood possibilities still needs to be awakened. It is one of the incidental benefits of a flood forecasting service that it would create wider public knowledge of the flood hazard, and thereby would hasten control and elimination of floods.

Simpler Seismic Analysis

STUDY OF EFFECTIVE MEANS of making structures resistant to earthquakes has brought out the fact that tall structures, such as high office buildings, cannot be considered as simple rigid structures. Flexibility must be taken into account, the amplitude and period of oscillatory deflections are involved, and altogether a good deal of refined analysis is necessary for safe proportioning. Buildings of moderate height may be analyzed more simply, however, and it is timely to place emphasis on this simplicity because there is a tendency toward refinement too extreme for application to structures of moderate proportions. The practical issue is safety with simplicity. In railroad bridge design the complex action of impact is allowed for quite simply by adding an impact percentage to the live load—a rough approximation but one that is both easy to apply and satisfactory in its results. May not a similar method be best suited to earthquake design of buildings? Seismic "impact" might range from 0.1 g for a massive dam to 1.0 g for the para-

pets of buildings. Such simple calculation is not new, for the fundamental reasoning began to be accepted after the Santa Barbara earthquake of 1925 and proved its worth in the Long Beach earthquake of 1933, where many buildings resisted the shocks safely while nearby structures collapsed. But it still lacks general acceptance. When simple and effective design procedure comes into general practice, safer construction will soon be universal.

What About Construction Safety?

IN A LIST of 30 major industries the construction industry stands third from the bottom in accident frequency and next to the bottom in severity of accidents. Why?

Because construction management is not safety minded. The industry rides along on the fallacious belief that "construction is different"; it holds to outworn traditions such as "a death per floor" and "a fatality for every 500,000 man-hours of exposure" as inescapable. In a word, construction lacks the will to do much about its accident record.

Any individualistic business, of course, is bound to resist the progress of reform, like that in safety. And construction is highly individualistic. Its many thousands of separate units—individuals and firms—tend to resent advice concerning the conduct of their business. So it happens that the safety measures that have actually come into practice have had to be forced by the insistence of labor and insurance interests and by engineers' specification requirements and supervision.

Construction operations are no more hazardous than many other production activities. Steel and cement manufacture, quarrying, railroading, mining and lumbering are but a few of the hazardous pursuits in which accidents have been reduced by intensive desire and effort. Construction's excuse that it differs from these because of its ever-changing locale of work and large turnover of labor is weak. Proof, were proof needed, may be found in the good safety record of WPA's construction in the face of the fact that the work was carried on largely with cast-offs and misfits from miscellaneous industries and trades.

The construction industry's fatalistic belief that there will be a serious accident or a death for so many tons of steel set or for so many man-hours worked is inexcusable. The facts give it the lie. To date there has not been a fatal accident in the erection of the Golden Gate Bridge, and in driving the Colorado River Aqueduct tunnels the Metropolitan Water District and its contractors have shown that this kind of work too can be carried on with few accidents.

The two projects mentioned show also *how* construction accidents can be controlled: Intelligent management that has the determination to conduct a safe job is the key. Though safety is thus well within reach, yet the construction organizations that have achieved real results in accident prevention constitute only a pitiful few. Among the best safety records in construction are those of an oil company, a public utility and a manufacturer. In these firms the safety movement of the whole company has been extended to the construction division with a success that once more proves that construction isn't different and that its accident problems are not insurmountable.

The difficulty in the promotion of construction safety is in reaching and then convincing the management. At present the insurance carriers through their safety engineers and inspectors are doing the best job of promotion, going far beyond their moral or financial obligation. Yet they meet with discouraging lack of cooperation. When contractors realize that the insurance companies are trying to help, not to hinder, when they realize that compensation and liability rates are fixed by construction experience and not by arbitrary designation on the part of the insurance carriers, and when they realize that safety is a financial advantage as well as a humanitarian movement, real progress in accident reduction will follow.

Safety can be promoted through contractors' associations, through cooperation with insurance carriers and with industrial commissions and by individual effort. Engineers can be of great aid in writing specific safety measures into their specifications. The sprawling congress type of meeting is of little effect, as evidenced at the recent National Safety Council meeting in Atlantic City, which barely half a dozen contractors attended.

First must come the will of management. Following this there needs to be never-ending safety effort throughout the organization, with infinite attention to detail operations. Safety in the long run pays financial dividends, and costs only time and effort. When this is realized, and when a determination to do something about safety is instilled into construction, only then will the industry's accident toll be reduced.

In Favor of Poor Building

NEWS REPORTS credit the Mortgage Bankers Association of America with passing a resolution scoring the use of governmental funds through the Federal Housing Administration. Even the mortgage bankers must know that the only purpose of the FHA is to insure the mortgage bankers' loans against loss, and to give the home loan borrower more of a fair deal than he has ever had before. The conclusion seems inescapable that the mortgage bankers resent this fair deal, that they would like to go back to loaning 50 per cent of the value of a property on a non-amortizable term mortgage whose renewal every four or five years is accompanied by the payment of various "extra charges."

If there is one new federal agency that private business can unanimously support, it would seem to be the FHA. It does not use federal funds except for administrative purposes, it puts mortgage borrowing on an amortizable, businesslike basis, it permits borrowing up to 80 per cent of the value of the property, and it requires quality building—which it assures by approving plans before construction and by inspecting the work during and after construction.

The quality building rules of the FHA are in many respects its crowning achievement. The mortgage bankers have never been interested in quality, have indeed shut their eyes to it, so long as there was a junk value in the property in excess of their loans. As a consequence every jerrybuilt development in the country is a monument to the mortgage methods in existence before the depression. To ask a return to such methods is almost inconceivable. For the mortgage bankers to suggest it, even under the spell of political emotionalism, should be a signal for the construction industry to link itself even more closely to the principles of good residential building established by the FHA.

CURRENT NEWS

First Contract Let On London Subway Program

The London Passenger Transport Board has just announced the placing of the first contract for the construction of new tunnels for the eastern extension of the Central London line of the Underground Railway. The entire extension program, which contemplates a line from Mile End to Woodford, is expected to cost about $75,000,000. The line will run underground from Mile End to Leyton, thence it will run over the tracks of the London & Northeastern Railway to Leytonstone, going underground there as far as Newbury Park. Thence it will continue over the London & Northeastern lines to Woodford.

The present contract is for the tunnel section from Mile End to Leyton. This section is being started first because the greater part of it will be in water-bearing strata, and it will take longer to complete than other sections. It is expected that the work will have to be done pneumatically. Tunneling will be done from four shafts.

Bay Bridge Tolls Under Discussion

The amount of the tolls to be charged for vehicles crossing the San Francisco-Oakland Bay Bridge, which will be opened to traffic on Nov. 12, has been the subject of much discussion. C. H. Purcell, chief engineer of the California Toll Bridge Authority, has recommended a schedule calling for a charge of 65 cents for automobiles and delivery trucks with not more than four passengers; 50-trip commutation tickets would be sold for $22.50. A charge of 50 cents would be made for automobile trailers; and trucks, truck-trailers, and buses would be charged 75 cents each with an additional charge of 5 cents per passenger. Motorcycles would pay 20 and 30 cents, respectively. A charge of 3½ cents per pound would be made for freight and for vehicles not covered in other classifications.

Railway Bridge Over Missouri Opened to Traffic

A new $3,250,000 Wabash railway bridge over the Missouri River at St. Charles, Mo. was opened to traffic on Oct. 13. The new bridge, which was financed by a PWA loan of $2,350,000, is about 1½ miles long with its approaches.

The new bridge includes two cantilever arms, each 156 ft. long, and a 312-ft. suspended span. The anchor arms are 431 and 274 ft. long, and there is a 316-ft. simple span. A minimum vertical clearance of 56 ft. above high water is provided in the navigation opening.

Silicon steel has been used for the primary load-carrying members of the trusses. Of the five main piers, four rest on solid rock, as much as 70 ft. below low water, and one is on a concrete pile foundation.

Work on the bridge started in 1930, was discontinued late in 1931, and resumed in April, 1935. The new bridge replaces a structure built in 1871. When it was built, the main span of the old bridge, 321 ft. in length, was the second longest in the country.

Court Jurisdiction Upheld in TVA Suit

Nashville court denies claim that action against TVA can be taken only in Alabama count

A MOTION made by TVA attorneys to dismiss the suit brought in U. S. District Court at Nashville, Tenn., by 19 utility companies was deneid on October 16. The suit challenges the constitutionality of the act establishing the TVA.

The motion to dismiss was based upon the claim that the Nashville Court lacked jurisdiction. Since a provision in the original TVA act established the authority's corporate home at Muscle Shoals, Ala., within the jurisdiction of the district court in Birmingham, the TVA argued that suit could only be brought in that court. The Nashville Court, however, ruled that since the present suit involves charges of wrongful and unlawful acts, the authority is subject in any court of competent jurisdiction where such acts are committed.

The next step will be to proceed to trial on the merits of the case, unless TVA decides to appeal to a higher court on the jurisdictional issue. It is not anticipated, however, that such an appeal will be made.

The West Tennessee Power & Light Co., of Jackson City, Tenn., obtained on October 14 from the Supreme Court of the District of Columbia a temporary injunction restraining the PWA from providing $663,000 for the construction of a municipal distribution system for TVA power at Jackson City. A large number of similar cases are now pending in the same court.

The Supreme Court has denied a request of the Alabama Power Co. and the Texas Utility Co. that suits which those companies had instituted challenging the power of the PWA to allot money to nine Alabama and Texas municipalities for construction of municipal power facilities be joined with the case of the Duke Power Co. versus Greenwood County, South Carolina. The request of the Alabama and Texas companies was an attempt to go directly from the District of Columbia Supreme Court, which upheld the power of PWA to make the loan, to the U. S. Supreme Court, eliminating the usual review by the U. S. Court of Appeals. Denial of the request means that the cases must follow the usual routine, although the decision in the Duke Power Co. case, which is expected to be tried on Nov. 11, will probably determine the disposition of all the other similar PWA power suits.

Falsework Fails On Binghamton Bridge

Failure of the wooden bents supporting an uncompleted concrete arch section of a bridge over the Chenango River at Ferry St. in Binghamton, N. Y., dropped a third of the arch into the river on Oct. 12.

The bridge, which is now under construction, replaces a steel bridge in the same place which was destroyed in the flood of July, 1935. The present bridge, which is being constructed as a PWA project, consists of three concrete barrel arches each with a span of 128 ft. 6 in. and a width of 65 ft. The arches are being constructed on steel falsework supported on timber bents. Each of the arches is being constructed one-third at a time.

Pouring of the first section of the first arch was completed on Oct. 8. Four days later on the 12th, the timber bents supporting the falsework failed under load, precipitating the hardened concrete into the river. No damage was done to the piers or abutments.

The McGraw Construction Co. of Philadelphia are the general contractors on the bridge.

A.S.C.E. Organizes Division to Study Soil Mechanics

The Soil Mechanics and Foundation Division of the American Society of Civil Engineers which was authorized by the Board of Directors at the annual convention in Portland was formally organized at the Pittsburgh meeting by the appointment of an executive committee. The members are Carlton S. Proctor, New York, chairman; J. F. Coleman, New Orleans; W. P. Creager, Buffalo; R. V. La Barre, Los Angeles, and F. A. Marston, Boston, with T. T. Knappen, New York, as secretary.

At the first meeting of the executive committee steps were taken to continue the research work of the old committee on Earths and Foundations by appointing a committee on Settlement of Foundations with Lazarus White as chairman, and a committee on Seepage. Other committees authorized were one on Review of Literature, with W. P. Creager as chairman, and one to report on the classification of soils and to prepare a glossary of terms and definitions in soil mechanics, with W. P. Kimball as chairman.

It was decided to hold the first technical session at the October, 1937 meeting in Boston; F. A. Marston was made chairman of the committee to handle the program. Because of the diversity of suggestions in the pre-organization letters from some 150 members who are now enrolled in the division, appointment of other committees was postponed to allow further discussion and study of their duties.

Illinois Health Department Sponsors Sanitary Conferences

The fourth annual conference on water purification to be sponsored by the Illinois State Department of Public Health will be held in Springfield, Ill., on Oct. 27-28. A program has been arranged by the division of sanitary engineering which is intended to promote economical and efficient operation of plants throughout the state. After a number of discussions of general interest, the conference will be divided into separate groups which will study water softening and iron removal, chlorination, purification, or laboratory methods.

On Oct. 13-14 the department, in conjunction with the sanitary water board, sponsored for the second time a short course for sewage treatment plant operators. Seventy-seven operators attended the course. The program was planned primarily to meet the needs of the operators of small plants, and, because of the short time available, only the most practical aspects of plant operation were emphasized. In general, the program included some talks on subjects of general interest, laboratory and lecture sessions, and round-table discussions of operations problems. The major part of the time was devoted to lectures and demonstrations on the use of laboratory control tests and the keeping of operation reports and records.

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Boulder Dam Surroundings Put Under Park Service

In recognition of the fact that Boulder Dam and Lake Mead are attracting large numbers of tourists, Secretary Ickes has announced plans by which the operation of the Boulder Dam plant will be retained by the Bureau of Reclamation, while the administration of nearby areas will be turned over to the National Park Service.

The Reclamation Bureau will continue to operate the dam and to supervise Boulder City, in which the operating personnel will live. It will provide tourist accommodations at Boulder City and a guide service for those who wish to inspect the works.

The National Park Service will develop the recreational potentialities of Lake Mead and of Eldorado Canyon below the dam. It will construct roads and trails, control the Boulder City Airport, and operate sightseeing airplanes and boats. There will be no interference with grazing along Lake Mead or with prospecting and mining within the recreational area.

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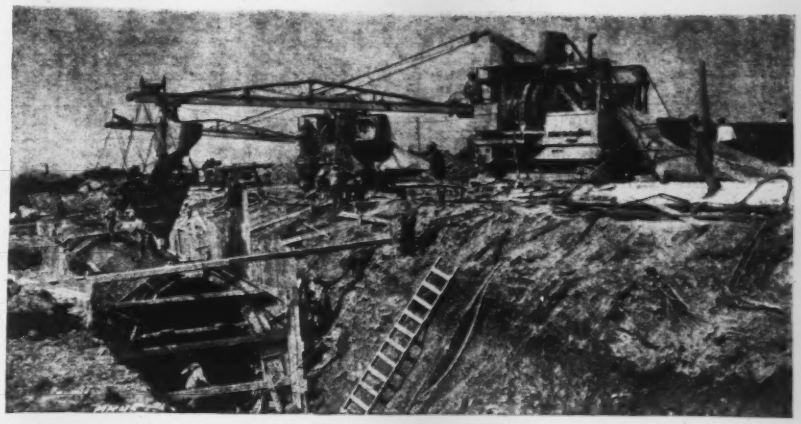
No Weather Effect From Lake Mead

Any possible effect of Lake Mead, formed by Boulder Dam, on precipitation in the surrounding area would be entirely negligible, according to calculations made by J. Cecil Alter, meteorologist for United States Weather Bureau. After receiving a large number of inquiries on the subject, Mr. Alter made his calculations and concluded that "Utah received in precipitation during the past twelve months 100 times as much water as could possibly have been evaporated from Lake Mead, and during August, 1936, received 150 times as much rain as could have come from the artificial lake. I doubt," he continued, "whether Utah received more than a few drops of rain from the Boulder Dam area. Moisture rising as vapor under ordinary conditions is diffused rapidly, and frequently travels 25 miles an hour, or 600 miles per day."

Mr. Alter stated that more than normal precipitation occurred in Utah in January, February, June, July and August, 1936, with February and July the wettest on record. However, in March, April, May and September, 1936 the precipitation has been below normal. These variations, Mr. Alter said, were no more than would normally be expected.



SPEEDING UP A SEWER JOB

Use of two mixers is speeding work on the West Town outlet sewer being built for the Sanitary District of Chicago by Herlihy-Midcontinent Co. The double set-up is being used on the 3,800-ft. open-cut section of the 11,000-ft. sewer. The sewer is of horseshoe section, 12 ft. 4½ in. by 14 ft. 9 in., heavily reinforced, and uses 3-1/3 cu.yd. of concrete per lineal foot. The mixers are mounted on crawlers and equipped with booms which permit the trolley buckets to deliver into a suspended receiving hopper spotted directly over the desired point of deposition.

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Washington Highlights

by Paul Wooton

The U. S. Supreme Court has agreed to review a test of the state of Washington's 2 per cent sales tax. The question at issue is whether this must be paid on purchases made outside of the state by contractors on Grand Coulee Dam.

Three Brazilian engineers are now on their way to Washington to confer with United States and Pan American Institute officials on plans for the proposed extension of the Pan American highway to Brazil. This extension is estimated to cost about $100,000,000.

A compilation made by the Bureau of Public Roads shows diversion of highway funds for non-highway purposes during 1935 amounting to $146,449,700; this is $24,000,000 more than during the preceding year. Diversion to general state, county, and municipal funds amounted to $86,000,000.

A special committee appointed by the state is investigating the constitutionality of the new Louisiana statute under which the state proposes to give assurances to the federal government that flowage rights for floodways along the Mississippi River will be furnished at a cost within the limits of the authorization carried in the Overton Act. In the meantime, the Mississippi River Commission is continuing its work on the flood-control plan. Land appraisal is well under way under the Bureau of Agricultural Engineering. Major General Edward M. Markham, Chief of Engineers, states that the engineers will be ready to start work before all flowage rights are obtained if a legal way can be found for the state to guarantee the federal government against damages in excess of the allowable figure of $22,225,000.

The Federal Trade Commission has issued a complaint against the U. S. Quarry Tile Co., of Canton, Ohio, alleging violation of the Robinson-Patman Act. It is alleged that the tile company gave 15 per cent discounts to wholesalers who, in fact, frequently acted as retailers, thus discriminating against the tile contractors not eligible for the discount.

PWA announces that as a result of the fact that it has been selling municipal bonds through RFC at a profit, municipalities have withdrawn more than $153,000,000 of bonds which PWA had agreed to accept but which the cities are now marketing elsewhere. On the first PWA program there were loans connected with nearly 50 per cent of the grand total but on the present program there are loans on only 6.25 per cent of the grant.

State highway officials are drafting legislation to be presented at forthcoming meetings of state legislatures authorizing them to use federal funds on country roads. This is in preparation for the two-year program of secondary road construction which begins next July. Actual selection of the roads that will make up this system cannot be made until surveys of traffic, now being conducted jointly by the state commissions and the Bureau of Public Roads, have been completed.

Bids Asked for Fresno Dam on Milk River Project

The United States Bureau of Reclamation will open bids Oct. 22 at Malta, Mont., for the construction of the Fresno dam on Milk River near Fresno, Mont., northwest of Havre. The dam, one of the major structures in the Milk River irrigation project, will be a rolled earth fill of 2,000,000 cu.yd., 2,100 ft. long and 80 ft. high. River diversion will be through a 12-ft. concrete conduit leading to an 18-ft. tunnel; part of the conduit will be carried on compacted backfill between two lines of steel sheet piling. Control works will be installed in the tunnel, as it will be used later as a reservoir outlet. The dam will have a paved spillway, and will be partly faced with heavy riprap.

The government will furnish all permanent construction materials, including sand, gravel, and broken rock, except steel lining required for the tunnel and calking material for drain pipes. A tentative completion date is set late in 1939.

SOCIETY CALENDAR

INTERNATIONAL ACETYLENE ASSOCIATION, annual convention, St. Louis, Mo. Nov. 18-20.

ASSOCIATED GENERAL CONTRACTORS, fall meeting of governing board, Washington, D. C., November 16-17.

HIGHWAY RESEARCH BOARD of the NATIONAL RESEARCH COUNCIL, annual meeting, Washington, D. C., Nov. 18-20.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual meeting, San Francisco, Calif., December 7-10.

AMERICAN WATER WORKS ASSOCIATION, MISSOURI VALLEY SECTION, Kansas City, Mo., October 26-28.

AMERICAN WATER WORKS ASSOCIATION, NORTH CAROLINA SECTION, and NORTH CAROLINA SEWAGE WORKS ASSOCIATION, joint meeting, Charlotte, N. C., Oct. 26-28.

CENTRAL STATES SEWAGE WORKS ASSOCIATION, annual meeting, Indianapolis, Ind. Oct. 29-30.

AMERICAN WATER WORKS ASSOCIATION, VIRGINIA SECTION, and VIRGINIA SEWAGE ASSOCIATION, joint meeting, Charlotteville, Va., Oct. 29-30.

Officers of the CANADIAN INSTITUTE OF SEWAGE AND SANITATION have been elected as follows: President, Grant R. Jack, Toronto; vice president, Norman J. Howard, Toronto; trustees, T. J. Lafreniere, Montreal, and W. C. Miller, St. Catherines, Ont.; secretary-treasurer, A. E. Berry, Toronto.

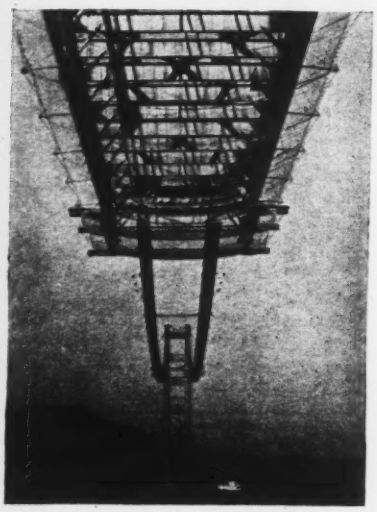
THE LOUISIANA POST of the SOCIETY OF AMERICAN MILITARY ENGINEERS has elected the following officers: President, Horace A. Thompson; vice-president, Col. William B. Gregory; treasurer, Walter C. Parey; secretary, Capt. George H. Hudson.

ASSOCIATION OF WESTERN STATE ENGINEERS, annual meting, Santa Fe, N. M., Dec. 3-5.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, MIDDLE ATLANTIC SECTION, fall meeting, New York City, Dec. 5.

LICENSE EXAMINATIONS

NEW YORK STATE, examination for professional engineers and surveyors, Jan. 25-27, at Albany, Buffalo, New York City and Syracuse. Applications must be filed with the State Education Department at Albany before Nov. 1.



NET UNDER GOLDEN GATE BRIDGE SAVES TWO LIVES

The rope safety net recently erected under the Golden Gate Bridge at San Francisco (ENR, Oct. 1, 1936, p. 487) saved two workmen within a period of ten days from a 220-ft. fall which would have meant certain death. Both men were carpenters. They fell from the roadway level into the net 35 ft. below.

In addition to the safety feature, the net is credited with speeding up construction because of the greater confidence with which the men move about the job. More than 160 tons of steel per traveler per day is being placed, which is a very high rate.

State of Washington Will Vote on Flood Control

A referendum bill is to be submitted to the voters of the state of Washington at the general election on Nov. 3 asking authorization for a state indebtedness of $15,000,000, to match federal and local funds for flood control work. The bill limits state participation to those flood control projects sponsored by duly established flood control districts and counties.

Electric power amendment

A proposed amendment to the state constitution which will also be submitted at the general election would authorize the state to engage in the production and wholesale distribution of electric energy and to assist in the development of hydroelectric generating plants. The principal purpose of this measure is to enable the state to market power to be produced at Grand Coulee dam. The amendment authorizes the state to incur indebtedness through the issuance of general obligation bonds to an amount not exceeding 3 per cent of the assessed valuation of all the property in the state and to issue utility or revenue bonds in amounts necessary for the purpose of providing funds with which to carry out the provisions of the act.

As a companion measure to the proposed constitutional amendment, about 20 counties will vote on the formation of power districts which would be able to buy power from the state. Three counties already have voted in favor of forming such districts.

Eight Millions Damage In Brazos River Flood

It is estimated that $7,882,650 of [illegible] was done in the recent flood of the [illegible] River and its tributaries (ENR, [illegible] 1936, p. 486). The losses are [illegible] as follows:

LOSSES IN BRAZOS FLOOD

Classification	Amount
Crop damage	$2,802,[illegible]
Livestock losses	[illegible]
Reduction in cotton crop	1,952,[illegible]
Highway and bridge damage	[illegible]
Damage to city of Waco	2,500,[illegible]
Ginned cotton damaged at Waco	[illegible]
Damage to city of Lampasas	[illegible]
Total estimated damage	$7,882,[illegible]

It is estimated that 448,650 acres were overflowed in the flood.

The Texas Senate on Oct. 6 passed and forwarded to the President a resolution urging that the $30,000,000 allocation to the Brazos River Conservation and Reclamation District for a program of constructing thirteen flood control dams on the Brazos be made available at once, so that work can start simultaneously on all the dams.

Constitutionality Of Relief Act Questioned

The constitutionality of the Emergency Relief Appropriation Act of 1935 has been questioned for the second time in a case now pending in federal district court. The case arose out of a criminal indictment against the Mesch Construction & Equipment Co. and M. C. Sellig, one of its officers, charging fraud against the government in connection with a contract of about $5,000 for laying a foundation for a city college library. The government charged that the defendant compiled false vouchers showing wage rates of $1.30 and $1.50 an hour, although only 75 cents an hour had been paid.

The defendant filed a demurrer to the indictment, charging that the relief act was unconstitutional. The arguments were based on the claims of unlawful delegation of legislative powers and violation of state rights.

The constitutionality question is also raised in a case now pending before the Supreme Court entered by the Potomac Electric Power Co. (*ENR*, July 23, 1936, p. 136).

Safety Provisions Included In Building Contract

Contracts recently let by the Mine Safety Appliances Co. of Pittsburgh, Pa., for construction of an addition to its plant facilities, embodied detailed provisions for safety measures which the contractor must take.

The contract stated that, "It is the intent of this contract that the various contractors and subcontractors shall provide all of the workmen on this building with proper modern safety appliances to be used in the performance of the various work requiring such protection; and the contractor and subcontractor shall provide in his estimate for providing these appli-

ances to the various workmen, and no workman will be permitted to work unless provided with the following safety appliances." The contract goes on to give detailed provisions that steel workers must wear protective hats, welding workers must wear welding goggles, men doing work that develops flying particles must wear protective goggles, all workers engaged in work which develops noxious fumes or dust shall wear respirators. The contractor is required to provide at the building site a suitable first aid kit and a suitable stretcher outfit.

It is stated that no objection to these provisions was met with from the contractors bidding on the job.

Nicholas S. Hill Dies

Nicholas S. Hill, Jr., president of the Hackensack Water Co. and a widely known consulting engineer on water problems, died on Oct. 18 in Greens Farm, Conn., at the age of 67.

Mr. Hill was a graduate of Stevens Institute of Technology. After his graduation from that institution he served as a mechanical engineer with the South Side Elevated Railroad in Chicago, and was later engaged to serve as engineer-secretary of the sewage commission of Baltimore, Md. He was afterwards appointed engineer of the electrical commission of Baltimore.

From Baltimore, Mr. Hill went to Charleston, S. C., as chief engineer and general manager of the Consolidated Railway Gas & Electric Co. of South Carolina. He later returned to Baltimore from Charleston to assume the duties of chief engineer of the Baltimore City Water Department. He was later appointed chief engineer of the Department of Water Supply, Gas and Electricity of New York City.

Enters private practice

Leaving his position in New York City, Mr. Hill entered private practice as a consulting engineer specializing in the design, construction, and operation of water supply and sewage disposal works and also in public utility valuation. During that time he served as consultant to many municipalities and privately owned water companies. He served as a consulting engineer to the New Jersey State Water Policy Commission reporting upon the sources of water supply of the state.

He was for many years consultant to the Hackensack Water Co. and in 1926 became its president. In 1927 he was awarded the Thomas Fitch Rowland prize of the American Society of Civil Engineers for his paper on the Oradell dam of the Hackensack Water Co. In 1931 he was retained by the municipal council of Shanghai, China, to make a study of the financial administration of the Shanghai waterworks.

Mr. Hill was a past president of the American Water Works Association and was at one time chairman of the committee on professional practice and ethics of the American Institute of Consulting Engineers and of the waterworks committee of the American Society for Municipal Improvements.

Passaic River Flood Plan Approved by Water Commission

The New Jersey Water Policy Commission, on Oct. 15, gave its approval to two projects for flood control on the Passaic River. The plans contemplate regulation of the river flow by deepening of the channel, removal of encroachments and some other improvements, and construction of flood gates at Dundee dam and the Great Falls dam. It was announced at the meeting that the owners of the dams, the Dundee Water Power & Land Co., and the Society for Establishing Useful Manufactures agreed with the proponents of the plan on the feasibility of flood gates. Although no detailed estimates have been prepared, it is believed that the cost of the project would be in the neighborhood of $5,000,000.

At the same meeting the commission refused its approval for a WPA project for cleaning the Passaic River channel in Paterson. The commission believes that this project should be held up until it could be coordinated with the larger scale program.

Brief News

A TIMBER ENGINEERING COMPANY is to be set up in the South under the auspices of the National Lumber Manufacturers Association and the American Forest Products Industries. Objectives of the new organization will be to encourage the greater use of wood in the construction of oil well derricks, to promote the use of wood in prefabricated houses, and to promote the development and use of fireproof and termite-proof lumbers.

THE PWA HAS BEEN ORDERED by the U. S. District Court at Washington, D. C., to show cause on Nov. 12 why it should not be required by mandamus to consider an application of the Metropolitan Bridge Co. for a loan and grant for the construction of a tube and bridge across San Francisco Bay. T. A. Tomasini, founder of the bridge company, is co-plaintiff in the suit. Mr. Tomasini informed the court that he obtained a franchise to construct a toll bridge across San Francisco Bay and had obtained permission from the War Department to carry out the franchise. He formed the bridge company and applied to PWA for the loan and grant, but the application was refused on the ground that the petitioners were not agencies of the sovereign power that granted the franchise.

TEST BORINGS IN THE EAST RIVER to determine conditions for the new East River Midtown Tunnel in New York City, on which work was started on Oct. 3, are being started this week under a $56,000 contract with the firm of Sprague & Henwood. Test borings were made several years ago, when the board of transportation mapped out a route for the vehicular tunnel, but new tests are required because the tunnel Authority has changed the route somewhat. Bids will soon be asked on a contract for sinking a construction shaft on the west bank of the river. Work is now proceeding on the east construction shaft.

DIVERSION OF THE COLUMBIA RIVER at Grand Coulee dam began on Oct. 7 with the placing of U-1, first of the large 85-ft. cross river cribs. It was sunk at the end of the smaller upstream crib. The crib weighed 275 tons.

AN INVESTIGATION OF THE CONDITION of buildings in the business district of New Orleans to determine whether any structures are unsafe and to order unsafe buildings repaired or demolished has been ordered by Mayor Maestri. The investigation followed an accident in which three workmen were killed by the collapse of a brick wall of a building being demolished. Inspection work in one block has already revealed three structures in need of repair, and their owners have been ordered to remedy the condition or demolish the buildings.

CHANGES IN THE PLANS for the Delaware-New Jersey tunnel under the Delaware River at Wilmington, eliminated all but one objection at a hearing held by the U. S. Engineers in Philadelphia on Oct. 12. This objection came from the Delaware-New Jersey Bridge Corp., which has plans to span the Delaware with a bridge and claims that its traffic surveys indicate that carrying charges can not be earned on any project costing more than $7,500,000. The original plans, which put the top of the tunnel 55 feet. below mean low water for 1,830 ft. in the middle of the river and 35 ft. below mean low water at the established pierhead line on the New Jersey side and which contemplated constructing the tunnel in open trench, had previously been criticized by navigation interests. The new plans call for a tunnel with a depth of 75 ft. below mean low water in the middle of the river for 1,000 ft. across the channel, rising to a clear depth of 40 ft. at the pierhead line on both sides of the river. The new plan also contemplates construction of the tunnel by shield boring. The cost is estimated at from ten to twelve million dollars.

Personals

BARTON REEVES has been appointed WPA project director for the Aurora, Neb., district with offices at Aurora.

C. H. SOUTHWORTH has resigned as district engineer and manager for the San Carlos Irrigation District in Arizona to take a position as assistant to the director of the irrigation service in the U. S. Indian Bureau, with headquarters at Washington.

D. H. STEWART, who was formerly divisional superintendent for the fourth division of the Colorado highway department, located at Pueblo, has been appointed acting superintendent of maintenance. Mr. Stewart relieves Robert Higgins, who has been granted a leave of absence due to ill health.

G. J. IRWIN, formerly assistant engineer of tests, bureau of tests, Ohio department of highways, has resigned to take a position with the machine and process development department of the B. F. Goodrich Co., where he will be in charge of the company's highway products engineering. Before joining the Ohio highway department, Mr. Irwin was for seven

years connected with the Portland Cement Association in Pittsburgh.

Obituary

EDWARD D. HARDY, an engineer specializing in water filtration work, died in San Diego on Oct. 7. Mr. Hardy was a graduate of the Thayer School of Civil Engineering.

ARTHUR J. REINHART, a building contractor of Dallas, Texas, and for several years street commissioner of that city, died in Wheatland, Texas, on Oct. 12 at the age of 45.

WILLIAM D. HOLT, chief engineer of the New Kensington Aluminum Works, died recently in New Kensington, Pa. Mr. Holt was a graduate in civil engineering of the University of Maine.

WILLIAM H. CHADWELL, a construction engineer with the Public Service & Gas Co. of New Jersey, died on Oct. 12 at the age of 57 in East Orange, N. J. Mr. Chadwell was a graduate of Stevens Institute of Technology and was formerly employed by the Essex & Hudson Gas Co.

ROBERT M. PATTERSON who, prior to his retirement in 1916, was superintendent of freight transportation for the Pennsylvania Railroad, died on Oct. 11 in Philadelphia at the age of 85. After his graduation from the University of Pennsylvania, Mr. Patterson joined the Engineer Corps of the Northern Pacific Railroad in 187[illegible]. In 1873 he entered the service of the Pennsylvania Railroad Co. After five years of service he resigned to practice engineering in Virginia, and in 1882 became division superintendent for the Buffalo, New York and Philadelphia Railroad. He returned to the Pennsylvania in 1885 as special agent in the office of the general superintendent of transportation. He was successively, superintendent of the Kensington & New York Division, general superintendent of the Pittsburgh terminal, and superintendent of freight transportation.

CONSTRUCTION STATISTICS FOR THE WEEK

ENGINEERING construction awards total $43,120,000 for the week, of which private work accounts for $10,866,000 and public work, $32,254,000, of this $3,675,000 is federal awards and $28,579,000 state and municipal. Corresponding values for a year ago are: total, $58,980,000; private, $18,095,000; public, $40,885,000; federal, $12,738,000; and state and municipal, $28,147,000.

Large volume of highway awards and heavier public awards in general raise this week's total above the volume reported for the short week last week. The classification totals are: industrial buildings, $4,739,000; commercial buildings, $4,601,000; public buildings, $6,734,000; highways, $12,844,000; bridges, $6,772,000; sewerage, $1,276,000; waterworks, $829,000; earthwork, drainage, $1,359,000; unclassified, $3,966,000.

The larger awards for the week include: new generating equipment in power plant, Louisville Gas and Electric Co.; Louisville, Ky., $1,800,000; psychiatric clinic and hospital and infirmary at State Hospital, Farmington, Mo., $511,000; armory, Teaneck, N. J., $796,000; buildings at Brooklyn State Hospital, Brooklyn, N. Y., $541,000; buildings at Los Angeles Junior College, Los Angeles, Calif., $574,000; highways, New York, $1,074,000; Massachusetts, $992,000; California, $1,734,000; Mississippi, $1,587,000; Georgia, $1,722,000; bridges, Massachusetts, $4,040,000; 68 snow pulverizers, removers and truck loaders, 42 Snogo type snow removal machinery, Department of Purchase, New York, N. Y., $956,000; airport improvements, Baltimore, Md., $1,333,000.

New capital added during the week includes PWA allotments, $13,015,000, and sales of state and municipal bond issues, $30,569,000.

CONTRACTS
(Thousands of Dollars)

	Weekly Average Oct. 1935	Prev. 4 Weeks 1936	Week Oct. 22 1936
Federal Government	$6,563	$4,939	$3,675
State and Municipal	17,907	23,754	28,579
Total public	$24,470	$28,693	$32,254
Total private	12,056	21,360	10,866
Week's total	$36,526	$50,053	$43,120
Cumulative to date:			
1935	$1,171,343,000	1936	$1,912,952,000

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

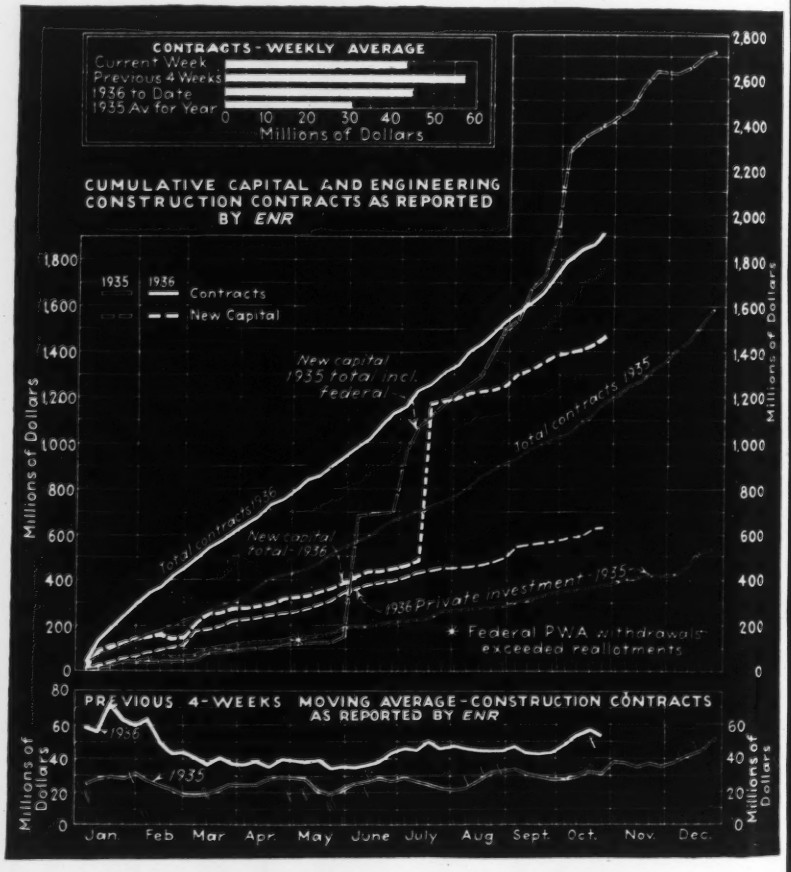
1936	Week Oct. 22	Cumulative
State and municipal	$10,569	$418,000
PWA non-federal	13,015	115,228
RFC loans	....	26,663
Corporate issues	....	204,359
PWA loans, Private	....	—1,665*
Total Non-Federal	$23,584	$762,585
Federal	....	691,237
Total new capital	$23,584	$1,453,822
Cumulative to date:		
1935	$2,384,481,000	1936 $1,453,822,000

* Bond sales in this classification exceed reallotments during current year.

Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities. RFC direct purchase of bonds for "self liquidating" projects, and 25 per cent of WPA construction appropriations.

INDEX NUMBER

ENR	1913 = 100	1926 = 100	ENR	1913 = 100	1926 = 100
Cost			Volume		
Oct., 1936	211.50	101.67	Sept., 1936	200	88
Sept., 1936	208.10	100.08	Aug., 1936	199	87
Oct., 1935	195.10	93.82	Sept., 1935	140	61
1935 (Av.)	195.22	93.84	1935 (Av.)	135	58
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	104	27


CONTRACTS - WEEKLY AVERAGE
Current Week
Previous 4 Weeks
1936 to Date
1935 Av for Year
0 10 20 30 40 50 60
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY ENR
1935 1936
Contracts
New Capital
New capital 1935 total incl. federal
Total contracts 1935
Total contracts 1936
New capital total 1936
1936 Private investment 1935
* Federal PWA withdrawals exceeded reallotments
Millions of Dollars
PREVIOUS 4-WEEKS MOVING AVERAGE - CONSTRUCTION CONTRACTS AS REPORTED BY ENR
1936
1935
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec

Current Construction Unit Prices

Waterworks and Sewers, Glenfield, Pa.

CONTRACT was awarded in August, 1936, for the construction of 3½ miles of cast-iron pipe line for the Glenfield, Pa., water and sewerage system. The major portion of the work is 4-in. and 6-in. pipe, and includes a 1,050-ft. river crossing of 8-in. line. Five bids were received, two of which were lower than the engineer's estimate. The project is financed thru PWA and is under the supervision of J. M. Rice, consulting engineer.

The following tabulation lists the unit prices and totals of the three low bidders: (A) Henry Butch, Pittsburgh, Pa. (contract) $50,411; (B) Mike Mannella, $50,544; (C) Frank Mannella & Sons, $54,114.

Item	A	B	C
1. Cast-iron pipe, 2in.—1,000 lin.ft.	$ .27	$ .34	$ .35
2. Cast-iron pipe, 4in.—6,000 lin.ft.	.53	.62	.70
3. Cast-iron pipe, 6in.—8,800 lin.ft.	.77	.86	.98
4. Cast-iron pipe, 8in.—1,650 lin.ft.	1.08	1.23	1.25
5. Cast-iron pipe, 8in., river—1,050 lin.ft.	1.17	1.30	2.00
6. Cast-iron specials to 4in.—483 lb.	.10	.15	.08
7. Cast-iron specials, 6in. plus—6,469 lb.	.06	.15	.08
8. Valves, 2in.—6, each	7.50	9.25	10.00
9. Valves, 4in.—8, each	13.00	14.75	20.00
10. Valves, 6in.—15, each	22.00	24.50	30.00
11. Valves, 8in.—4, each	34.00	37.30	45.00
12. Valve boxes—27, each	3.80	4.00	5.00
13. Fire hydrants, type A—3, each	67.00	70.00	90.00
14. Fire hydrants, type B—12, each	80.00	90.00	110.00
15. Excavate, lay 2in. pipe—1,000 lin.ft.	.75	.85	.60
16. Excavate, lay 4in. pipe—6,000 lin.ft.	.80	.95	1.00
17. Excavate, lay 6in. pipe—8,800 lin.ft.	1.35	1.00	1.20
18. Excavate, lay 8in. pipe—1,650 lin.ft.	.95	1.50	1.40
19. Excavate, place fire hydrants—15, each	25.00	15.00	20.00
20. Excavate, lay river pipe—total	8,650	6,500	6,000
21. Excavate, lay 12in. sewer—600 lin.ft.	4.00	3.00	4.00
22. Sewer manholes—1, each	75.00	90.00	100.00
23. Manhole frame & cover—1, each	20.00	15.00	16.00
24. Manhole steps—10, each	1.00	1.00	1.00
25. Lateral sewer connections, 6in.—6, each	15.00	10.00	2.00
26. Concrete—88 cu.yd.	20.00	10.00	14.00
27. Extra excav. below pool—20 cu.yd.	10.00	5.00	4.00
28. Extra excav. above pool—30 cu.yd.	5.00	2.50	2.00
29. Remove, replace brick pave't., slag base—4,350 lin.ft.	.45	1.00	1.00
30. Remove, replace brick pave't., concrete base—120 lin.ft.	1.20	3.00	2.00
31. Remove, replace slag pavement—100 lin.ft.	.30	1.00	.80

Sixth Ave. Subway, New York City

THE THIRD SECTION of the Sixth Ave. subway, the last link in the Manhattan lines of the New York Independent Subway System, was placed under contract late in September, 1936. The section, known officially as Route 101, Sect. 8, extends from 27th to 34th Sts. in Sixth Ave. and involves serious construction difficulties. The Sixth Ave. Elevated RR. columns will have to be supported temporarily and then transferred to the roof of the subway structure. The subway line crosses diagonally under the four-track B.M.T. subway line at 33d St., involving subway structure support and reconstruction of part of the B.M.T. station. At 32d St. and again at 33d St. the subway cuts through the roof of busy double-track tunnels of the L. I. RR. Underpinning will be required for 64 buildings and one statue. At 33d St. is the terminal station of the Hudson & Manhattan RR., which runs underground up Sixth Ave. from Ninth St. A temporary terminal will be established at 28th St. while the present station is being remodelled to accommodate both tube and subway traffic.

Following are unit prices submitted to the New York Board of Transportation, Jesse Snow, chief engineer, by the three lowest of seven bidders. (A) Carleton Co., Inc. (contract) $6,392,879; (B) George H. Flinn Corp., $6,411,623; (C) Underpinning & Foundation Co., Inc., $6,895,525.

THIRD SECTION SIXTH AVE. SUBWAY, NEW YORK

Item	A	B	C
1. Earth excav.—65,000 cu.yd.	$5.30	$9.00	$15.00
2. Rock excav.—35,000 cu.yd.	9.10	14.00	15.00
3. Tunnel excav.—17,900 cu.yd.	13.40	18.00	17.30
4. Decking—12,200 sq.yd.	17.00	20.00	43.35
5. Tunnel timbering—75 M.L.b.m.	100.00	100.00	100.00
6. Steel supports—11 tons	100.00	100.00	100.00
7. Earth fill—1,900 cu.yd.	1.50	3.80	3.92
8. Concrete, Cl. A—31,800 cu.yd.	20.50	21.00	24.40
9. Concrete, Cl. B—1,600 cu.yd.	$19.75	$18.50	$24.40
10. Protective conc. masonry—4,300 cu.yd.	21.70	21.50	46.30
11. Concrete finish—151,400 sq.ft.	.13	.13	.19
12. Brick masonry—350 cu.yd.	34.00	35.00	50.00
13. Hollow tile masonry—900 cu.yd.	30.00	35.00	50.00
14. Non-slip tile treads—1,400 sq.ft.	3.00	2.30	4.70
15. Remove masonry—21,600 cu.yd.	27.50	25.00	23.50
16. Grout—200 bbl. cement	6.00	6.00	9.40
17. Precast concrete arches—1,300 sq.yd.	5.00	7.00	23.50
18. Riveted steel shapes—4,700 tons	127.00	115.00	122.00
19. Architectural steel & iron—20 tons	350.00	350.00	315.00
20. Emer. exit covers, tracks—2 each	700.00	500.00	1,100
21. Emer. exit covers, stations—1, each	150.00	400.00	1,100
22. Reinf. steel—340 tons	100.00	105.00	122.00
23. Steel doors, type "J"—190 sq.ft.	10.00	5.00	9.40
24. Steel doors, type "JA"—65 sq.ft.	10.00	6.00	9.40
25. Misc. iron castings—22 ton	175.00	150.00	251.00
26. Wire mesh—5,600 lb.	.25	.15	.39
27. Expanded metal lath—240 sq.yd.	.80	.45	.70
28. Ribbed metal lath—340 sq.yd.	.85	1.00	.74
29. One-ply waterproofing—7,500 sq.yd.	.75	.55	.50
30. Three-ply waterproofing—11,800 sq.yd.	2.00	1.60	1.50
31. Four-ply waterproofing—12,500 sq.yd.	2.90	2.15	2.00
32. Dry-ply waterproofing—1,100 sq.yd.	.50	.30	.30
33. One brick layer, mastic—600 cu.yd.	48.00	37.00	40.00
34. Asphalt mastic waterproofing—25 cu.yd.	60.00	37.00	40.00
35. Asphalt mastic mop coat—450 cu.yd.	.65	.35	.30
36. Vitrif. clay ducts, 1 way—115,200 duct. ft.	.25	.25	.30
37. Vitrif. clay ducts, 4 way—800 duct.ft.	.30	.30	.30
38. Fibre ducts, 3in.—540 duct.ft.	.45	.35	.40
39. Fibre ducts, 3½ in.—11,000 duct.ft.	.50	.40	.45
40. E.H. galv. steel cable feed pipe, 6in.—80 lin.ft.	6.00	16.00	5.00
41. E.H. galv. steel cable feed pipe, 10in.—60 lin.ft.	10.00	18.00	10.00
42. E.H. galv. steel cable feed pipe, 10in.—240 lin.ft	50.00	21.00	40.00
43. C.I. pipe, 3in.—1,500 lin.ft.	1.25	1.07	.90
44. C.I. pipe, 4in.—940 lin.ft.	1.50	1.28	1.20
45. C.I. pipe, 6in.—100 lin.ft.	2.00	1.70	1.50
46. C.I. pipe, 8in.—125 lin.ft.	4.50	2.34	2.00
47. C.I. pipe, 10in.—60 lin.ft.	3.00	3.17	2.50
48. C.I. pipe, 12in.—25 lin.ft.	4.00	4.75	3.00
49. E.H. cast iron pipe, 3in.—100 lin.ft.	2.80	1.07	1.50
50. E.H. cast iron pipe, 4in.—15 lin.ft.	2.50	2.08	2.00
51. E.H. cast iron pipe, 6in.—130 lin.ft.	3.00	2.70	2.50
52. Cement lined copper steel, 3in. pipe—250 lin.ft.	1.50	1.07	1.00
53. Cement lined copper steel, 4in. pipe—700 lin.ft.	2.25	1.28	1.20
54. Cement lined copper steel, 6in. pipe—1,150 lin.ft.	3.00	1.90	1.50
55. Cement lined copper steel, 8in. pipe—400 lin.ft.	3.50	2.82	2.50
56. Std. galv. steel pipe, 8in.—60 lin.ft.	3.00	4.17	4.00
57. Vitrified drain pipe, 4in.—85 lin.ft.	.50	1.70	1.00
58. Vitrified drain pipe, 6in.—140 lin.ft.	1.00	2.14	1.50
59. Vitrified drain pipe, 12in.—50 lin.ft.	2.30	3.17	2.50
60. Back pressure valves, 4in.—6, each	25.00	21.00	30.00
61. Copper tubing—160 lin.ft.	1.00	1.58	2.00
62. Copper inlet lining—20, each	3.00	7.34	10.00
63. Vitrif. sewer connections, 12in.—500 lin.ft.	5.45	3.75	2.58
64. Vitrif. sewer connections, 15in.—300 lin.ft.	6.85	5.34	3.00
65. Vitrif. sewer connections, 18in.—250 lin.ft.	7.65	6.42	4.00
66. Vitrif. sewer connections, 24in.—350 lin.ft.	10.00	7.42	5.00
67. C.I. sewer pipe, straight pipe—25 ton	125.00	90.00	160.00
68. C.I. sewer pipe, special—15 ton	225.00	200.00	260.00
67. Reinf. conc. sewer, egg shape, 3 ft. 6 in. x 2 ft. 4 in.—1,000 lin.ft.	15.50	16.00	25.00
68. Reinf. conc. sewer, egg shape, 4 ft. x 2 ft. 6 in.—35 lin.ft.	20.00	19.00	30.00
69. Spurs, misc.—80, each	5.00	2.17	6.00
70. Risers, misc.—60 lin.ft.	5.00	3.17	4.00
71. House sewers, to 8in.—125 lin.ft.	4.10	3.17	5.00
72. House sewers, over 8in.—50 lin.ft.	5.00	4.17	6.00
73. Vitrif. brick, granite block lining—1,000 sq.yd.	6.00	5.34	7.00
74. Steel elec. conduit, ¾ in.—3,500 lin.ft.	.50	.35	.25
75. Steel elec. conduit, 1 in.—4,000 lin.ft.	.60	.40	.30
76. Steel elec. conduit, 1¼ in.—21,000 lin.ft.	.85	.50	.35
77. Steel elec. conduit, 1½ in.—130 lin.ft.	.95	.75	.40
78. Steel elec. conduit, 2in.—700 lin.ft.	1.00	1.05	.60
79. Steel elec. conduit, 3in.—20 lin.ft.	1.80	1.78	1.00
80. Steel elec. conduit, 4in.—1,600 lin.ft.	2.25	2.44	2.00
81. C.I. outlet boxes, 4x4x2 in.—25, each	1.40	.90	1.25
82. C.I. outlet boxes, 4x4x3 in.—950, each	1.50	1.00	1.35
83. C.I. pull boxes, 6x6x4 in.—120, each	6.00	4.17	3.50
84. C.I. pull boxes, 6x12x3 in.—2, each	20.00	21.00	6.50
85. C.I. pull boxes, 6x12x4 in. each	30.00	26.00	20.00
86. C.I. pull boxes, 6x4x4 in.—4, each	6.00	3.17	4.00
87. C.I. pull boxes, 8x6x4 in.—15, each	9.00	7.34	4.00
88. C.I. pull boxes, 8x6x6 in.—20, each	10.00	8.34	5.00
89. C.I. pull boxes, 8x8x6 in.—25, each	13.00	10.34	5.50
90. C.I. pull boxes, 12x18x2½ in.—1, each	40.00	31.00	20.00
91. Boxes, steel trim & door, 6x12x14 in.—6, each	40.00	37.00	30.00
92. Boxes, hinged C.I. cover & lock, 6x12x14 in.—2, each	30.00	42.00	20.00
93. Ventilation gratings, sidewalks—1,900 sq.ft.	2.30	2.00	2.25
94. Ventilation gratings, misc.—250 sq.ft.	1.50	2.60	2.25
95. Station entrance covers—10, each	35.00	60.00	200.00
96. Stairwell covers, metal covered—3, each	100.00	60.00	300.00
97. Restore street asphalt—1,100 sq.yd.	5.00	3.50	3.50
98. Restore street granite block—85 sq.yd.	8.00	8.50	3.50
99. Restore street surfaces in curbs—660 sq.yd.	6.50	2.70	5.00
100. Bluestone curb, 5in.—195 lin.ft.	2.00	3.00	3.00
101. Bluestone curb, 6in.—30 lin.ft.	2.50	3.00	3.20
102. Bluestone curb, 8in.—30 lin.ft.	3.50	3.50	4.00
103. Reset bluestone curb—225 lin.ft.	1.50	1.50	2.00
104. Reset granite curb—105 lin.ft.	1.50	2.00	2.50
105. Park surfaces restored—400 sq.yd.	8.50	4.26	5.00
106. Temp. roadway pavement—9,100 sq.yd.	2.90	2.08	2.50
107. Temp. sidewalk pavement—5,300 sq.yd.	3.00	2.08	2.50
108. Upper 3in. concrete walls—50 sq.yd.	3.50	3.20	7.00
109. New trees—11, each	100.00	50.00	30.00
110. Maintain Penna. R.R. tunnel—total	265,000	121,000	63,000
111. Support B.M.T. subway—total	30,000	90 000	23,500
112. Support 6th Ave. "L" cols.—26 per col.	6,000	4,500	4,780
113. Support 6th Ave. "L" cols. on H & M roof.—10 per col.	2,000	600.00	3,780

THIRD SECTION SIXTH AVE. SUBWAY, NEW YORK

Item	A	B	C
114. Support 6th Ave. "L" cols. H & M structure—6 per col.	$2,200	$1,000	$7,700
115. Support 6th Ave. "L" cols. H & M structure—4 per col.	2,400	4,500	3,780
116. Support 6th Ave. Sta. "L" cols. R.R. struct.—7 per col.	6,000	3,800	9,400
117. Support 6th Ave. Sta. "L" cols. R.R. struct.—4 per col.	23,000	1,000	9,400
118. Support 6th Ave. Sta. "L" cols., stairways—2 per col.	2,000	3,300	5,800
119. Support misc. "L" cols., H & M structure—32 per col.	1,000	600.00	315.00
120. Support 6th Ave. R.R. cols. E. & W. 28th St.—4 each.	1,000	1,500	6,300
121. Maintain H & M R.R.—total.	25,000	118,000	18,800
122. Remove materials, H & M R.R.—total.	1.00	1,000	1.00
123. Remove 6th Ave surface R.R.—2,000 lin.ft.	12.00	20.00	20.00
124. Lay 6 in. C.I. low press. water pipe—250 lin.ft.	1.75	1.67	1.50
125. Lay 12 in. C.I. low press. water pipe—1,055 lin.ft.	3.00	3.34	2.00
126. Lay 20 in. C.I. low press. water pipe—1,010 lin.ft.	10.00	4.42	3.00
127. Lay 8 in. C.I. high press. water pipe—185 lin.ft.	10.00	5.00	3.00
128. Lay 12 in. C.I. high press. water pipe—935 lin.ft.	15.00	6.50	4.00
129. Lay 16 in. C.I. high press. water pipe—155 lin.ft.	20.00	8.00	5.00
130. New C.I. hub & spigot str. pipe—30 ton	100.00	75.00	100.00
131. New C.I. hub & spigot str. pipe, special castings 10 ton	200.00	185.00	165.00
132. New C.I. spigot & grooved str. pipe—25 ton	150.00	100.00	125.00
133. New C.I. spigot & grooved str. pipe, special castings—10 ton	270.00	200.00	170.00
134. New Steel water pipe—5 ton	330.00	210.00	300.00
135. Water service connections through vents—5, each	150.00	110.00	80.00
136. Water service connection through vents reconstructed—18, each	50.00	80.00	150.00
137. Lay 6 in. steel gas pipe—560 lin.ft.	1.75	1.37	1.00
138. Lay 8 in. steel gas pipe—15 lin.ft.	2.00	1.95	1.20
139. Lay 10 in. steel gas pipe—470 lin.ft.	2.25	2.54	1.50
140. Lay 12 in. steel gas pipe—15 lin.ft.	2.50	3.13	1.75
141. Lay 16 in. steel gas pipe—80 lin.ft.	4.00	3.72	2.00
142. Lay 20 in. steel gas pipe—935 lin.ft.	5.00	3.72	3.00
143. Lay 24 in. steel gas pipe—10 lin.ft.	6.00	4.51	5.00
144. New 6 in. steel gas pipe—510 lin.ft.	.72	.72	.72
145. New 8 in. steel gas pipe—10 lin.ft.	1.07	1.07	1.07
146. New 10 in. steel gas pipe—430 lin.ft.	1.46	1.46	1.46
147. New 12 in. steel gas pipe—10 lin.ft.	1.54	1.54	1.54
148. New 16 in. steel gas pipe—75 lin.ft.	2.16	2.16	2.16
149. New 20 in. steel gas pipe—850 lin.ft.	2.94	2.94	2.94
150. New 24 in. steel gas pipe—5, each.	4.05	4.05	4.05
151. New 6 in. Dresser couplings—45, each.	2.42	2.42	2.42
152. New 8 in. Dresser couplings—2, each.	2.81	2.81	2.81
153. New 10 in. Dresser couplings—35, each.	3.41	3.41	3.41
154. New 16 in. Dresser couplings—5, each.	5.83	5.83	5.83
155. New 20 in. Dresser couplings—60, each.	8.21	8.21	8.21
156. New 4 in. Dr. reducer couplings—3, each.	4.40	4.40	4.40
157. New 6 in. Dr. reducer couplings—8, each.	5.46	5.46	5.46
158. New 12 in. Dr. reducer couplings—3, each.	14.45	14.45	14.45
159. New 16 in. Dr. reducer couplings—3, each.	20.79	20.79	20.79
160. New 20 in. Dr. reducer couplings—6, each.	29.32	29.32	29.32
161. New 24 in. Dr. reducer couplings—1, each.	44.84	44.84	44.84
162. New 6 in. valves—5, each.	38.69	38.69	38.69
163. New 10 in. valves—4 each.	79.04	79.04	79.04
164. New 16 in. valves—1, each.	145.14	145.14	145.14
165. New 20 in. valves—9, each.	234.86	234.86	234.86
166. Special square valve boxes—10, each.	10.37	10.37	10.37
167. Special long valve boxes—9, each.	12.55	12.55	12.55
168. Gas service conn. vents—2, each.	70.00	110.00	80.00
169. Gas service conn. reconst.—6, each.	50.00	80.00	100.00
170. New 6 in. gas by-pass—400 lin.ft.	5.00	12.00	10.00
171. New 12 in. gas by-pass—440 lin.ft.	8.00	20.00	20.00
172. New 20 in. gas by-pass—2,900 lin.ft.	12.00	30.00	40.00
173. New 30 in. gas by-pass—50 lin.ft.	40.00	45.00	60.00
174. New 30 in. gas by-pass, above surf.—350 lin.ft.	25.00	35.00	60.00
175. Cable suspension over 16 in. dia.—220 lin.ft.	60.00	40.00	30.00
176. Vit. clay elec. ducts—78,500 duct.ft.	.65	.45	.80
177. Fibre elec. ducts, 3½ in.—10,900 duct ft.	.50	.45	.80
178. Maintain 2½ in. steel pipe elec. ducts—6,700 ft.	.20	.35	1.00
179. Maintain, 3 in. ducts—7,100 ft.	.20	.40	1.00
180. Maintain, 3½ in. ducts—3,600 ft.	.20	.45	1.00
181. Maintain, 4 in. ducts—900 ft.	.20	.60	1.00
182. New 1½ in. steel pipe ducts—100 ft.	.30	.70	.60
183. New 2 in. steel pipe ducts—800 lin.ft.	.30	.75	.80
184. New 2½ in. steel pipe ducts—2,200 lin.ft.	.50	.95	1.00
185. New 3 in. steel pipe ducts—4,800 lin.ft.	.60	1.05	1.25
186. New 3½ in. steel pipe ducts—1,050 lin.ft.	.70	1.25	1.50
187. New 4 in. steel pipe ducts—350 lin.ft.	.80	1.80	2.00
188. Sleeves, elec. ducts, misc.—6, each.	17.50	20.00	10.00
189. Maintain junction boxes—8, each.	500.00	160.00	100.00
190. Underpin 64 bldgs. and 1 statue—total unit bids.	488,600	409,450	147,400
191. Remove, maintain iron fences, stone.	2,200	5,000	6,300
192. Furnish, place dowels—600, each.	2.50	2.11	3.15
193. Tile, glazed, misc.—20,000 sq.ft.	1.00	.75	1.00
194. Tile, weatherproof—2,000 sq.ft.	1.25	1.50	2.50
195. Ceramic tile—340 sq.ft.	5.00	3.00	3.00
196. Glazed t.c. cape—1,200 lin.ft.	1.60	1.00	1.00
197. Mouldings—2,100 lin.ft.	1.50	.90	1.00
198. Plaster on masonry—4,000 sq.yd.	2.00	1.00	1.20
199. Plaster, misc.—1,100 sq.yd.	2.20	1.50	1.20
200. Cement wainscot, base—3,200 sq.ft.	.45	.35	.20
201. Finish on masonry—120 sq.ft.	2.00	.25	.20
202. Floor finish, 3 in.—70,000 sq.ft.	.25	.10	.40
203. Panels—1,800 sq.ft.	2.00	.12	.20
204. Concrete copings, street—265 cu.ft.	2.00	1.75	2.00
205. Concrete copings, subway—350 cu.ft.	1.00	1.50	2.00
206. Concrete stairs, self supp't'g—2,500 lin.ft. tread	1.50	1.25	3.00
207. Supported stair—2,060 lin.ft. tread.	1.50	.50	3.00
208. Treads—1,700 sq.ft.	2.00	.75	2.00
209. Wall strings—650 lin.ft.	1.00	.50	1.00
210. Metal change booths, HM1—1, each.	2,500	2,000	600.00
211. Metal change booth, HM2—1, each.	2,300	1,500	500.00
212. Metal change booth, HM3—2, each.	1,200	1,000	200.00
213. Metal change booth, HM4—2, each.	1,200	1,000	200.00
214. Kalamein booths, HK1—2, each.	850.00	450.00	400.00
215. Kalamein booths, HK2—2, each.	650.00	375.00	300.00

THIRD SECTION SIXTH AVE. SUBWAY, NEW YORK

Item	A	B	C
216. Portable safes—3, each.	$150.00	$263.00	$200.00
217. Drum type safes—3, each.	400.00	103.00	200.00
218. Metal news stands—2, each.	1,200	2,000	300.00
219. Metal stalls—pay toilets—14, each.	70.00	50.00	80.00
220. Metal stalls—additional posts—4, each.	16.00	12.00	20.00
221. Kalamein d.h. windows, 1½ in.—190 sq.ft.	5.00	3.50	3.50
222. Kal. d.h. windows, 1¾ in.—50 sq.ft.	4.90	3.40	3.00
223. Kal. windows, 1¾ in. stat.—20 sq.ft.	4.00	2.50	2.50
224. Vent doors—33, each.	40.00	25.00	35.00
225. Bay window—1, each.	150.00	125.00	150.00
226. H.M. doors, GaH—16, each.	100.00	25.00	75.00
227. Kalamein doors, D—21, each.	75.00	90.00	60.00
228. Kalamein doors, F—2, pair.	120.00	100.00	100.00
229. Kalamein doors, M—7, each.	70.00	80.00	60.00
230. Kalamein doors, P—7, each.	35.00	35.00	25.00
231. Kalamein doors, Y—1, set.	170.00	140.00	150.00
232. Kalamein doors, Da—4, each.	75.00	75.00	60.00
233. Kalamein doors, DL—1 each.	75.00	65.00	60.00
234. Kalamein doors, FL—1 pair.	120.00	100.00	100.00
235. Kalamein doors, HL—5, each.	75.00	65.00	60.00
236. Kalamein doors, ML—2, each.	70.00	60.00	60.00
237. Railings, F—100 lin.ft.	7.00	4.00	4.00
238. Railings, Fa—20 lin.ft.	7.50	5.00	4.50
239. Railings, G—350 sq.ft.	1.50	.80	1.00
240. Railings, L—160 lin.ft.	7.50	2.75	4.50
241. Railings, B—130 sq.ft.	2.00	1.05	1.50
242. Steel chains—8, each.	12.00	15.00	7.00
243. Gates, low, sliding—16 lin.ft.	24.00	15.00	20.00
244. Gates, high, sliding—20 lin.ft.	30.00	14.00	25.00
245. Gates, high, folding—50 lin.ft.	20.00	20.00	15.00
246. Gates, low, folding—15 lin.ft.	20.00	14.00	15.50
247. Gates, high, swing—22 lin.ft.	20.00	15.00	15.00
248. Extra gate posts—13, each.	18.00	20.00	10.00
249. Vent posts—1, each.	600.00	250.00	300.00
250. Signs, enamel plates—380 sq.ft.	2.00	1.50	1.00
251. Signs, enamel, A—350 sq.ft.	4.00	1.50	1.20
252. Street railings, KB—3, stairwell.	700.00	240.00	300.00
253. Street railings, KBi—5, stairwell.	900.00	300.00	300.00
254. Store fronts—total.	25,000	8,000	6,000
255. Oak hand rails—1,100 lin.ft.	.50	1.00	.75
256. Wire mesh screens over toilets—200 sq.ft.	1.00	.75	1.00
257. New platform edge—2,200 lin.ft.	1.00	.70	1.00
258. Reset old edge—60 lin.ft.	3.00	1.50	5.00
259. Plumbing, heating, 28th St. Station—total.	5,000	1,800	2,500
260. Plumbing, heating, 33rd St. Station—total.	11,000	11,000	5,500
261. Comfort station plumbing, heating—total.	12,000	11,000	5,500
262. Slate, pipe chamber partition—480 sq.ft.	2.00	1.50	.70
263. Slate toilet partitions—70 sq.ft.	2.00	2.00	.70
264. Slate corners, angles—35 lin.ft.	1.50	2.00	1.50
265. Slate stiles, caps—15 sq.ft.	2.00	2.00	1.50
266. Register faces, vents—10, vent.	20.00	12.00	6.00
267. Register faces, with louvres—16, register.	15.00	10.00	6.00
268. Register faces, without louvres—12, register.	13.00	5.00	4.00
269. C.I. heater boxes—6, each.	65.00	40.00	20.00
270. Panel Board boxes, 6x27 in.—9, each.	150.00	100.00	60.00
271. Paint on masonry—130,000 sq.ft.	.10	.10	.03
272. Soda fountain enclosure—total.	15,000	1,700	2,000
273. Misc. work, 28th St. toilet—total.	2,000	1,200	3,000
274. Misc. work, comfort station—total.	15,000	6,000	22,000
275. Alter change booth, 28th St. station—total.	2,000	500.00	42,000
276. Permanent bumping posts—3, each.	500.00	300.00	200.00
277. Temporary bumping posts—2, each.	800.00	300.00	200.00
278. Anticreepers—725, each.	.60	.30	.45
279. Ballasted track, unguarded tan.—400 lin.ft.	10.00	5.60	4.50
280. Guarded tang. & curves—190 lin.ft.	20.00	7.25	7.50
281. Remove H & M track, special work—total.	20,000	12,000	9,000
282. Concreted track, unguarded tang.—1,200 lin.ft.	18.00	5.60	4.50
283. Concreted track, guarded tangents—25 lin.ft.	23.00	7.25	7.50
284. Broken stone ballast—600 cu.yd.	8.00	5.00	4.50
285. Fibre conduit, water pfd., 3½ in.—100 cond.ft.	5.00	2.00	1.00
286. Special work, portion HM-1—total.	60,000	50,000	30,000
287. Special work, portion HM-2—total.	35,000	30,000	15,000
288. Contact rail, appurtenances—2,600 lin.ft.	3.00	1.50	1.30
289. Contact rail protection, appurtenances—2,800 lin.ft.	1.00	.45	1.10
290. Contact rail splices—75, splice.	18.00	10.00	4.50
291. Contact rail end inclines—35, each.	30.00	20.00	5.50
292. Contact rail side inclines—8, each.	80.00	20.00	9.00
293. Contact rail anchors—90, each.	35.00	12.00	9.00
294. Insulated splices, continuous—35, each.	28.00	15.00	9.00
295. Insulated splices, twin—30, each.	45.00	25.00	11.00
296. Furnish, rearrange D.C. connections, 28th St.—total.	81,600	65,000	30,000
297. Remove D.C. connections, 33rd St.—total.	12,840	12,000	2,700
298. Reequip D.C. connections, 33rd St.—total.	47,800	85,000	45,000
299. Remove unused D.C. connections—total.	6,000	10,000	6,000
300. Reinstal 32nd St. fan at 28th St.—Total.	7,000	15,000	6,000
301. Reinstal 2nd 32nd St. fan at 28th St.—total.	4,000	6,500	3,500
302. Reinstal 32nd St. fans; 28th St. fan at 30th St.—total.	36,132	33,000	24,000
303. Instal 25 damper assemblies, 5 registers—total.	13,200	15,000	12,000
304. Instal 2nd 28th St. fan at 30th St.—total.	3,500	6,500	3,000
305. Remove drainage equipment—total.	3,700	7,000	3,300
306. Drainage equipment at reconst. station—total.	15,000	18,500	13,500
307. Remove 2 ejector pots, 28th St. Sta. to storage—total.	1,000	2,500	900.00
308. Ejector pit, compressor equip. public comfort sta.—total.	7,100	9,000	6,400
309. Lighting equipment, 28th St.—total.	20,000	29,000	21,000
310. Remove, store, lighting equip. 33rd St. Sta.—total.	3,600	18,000	11,000
311. Lighting equipt. 33rd St. Sta., comfort sta.—total.	44,500	102,500	78,000
312. Remove, store, 28th St. transformer & light. equipt.—total.	1,200	3,000	1,300
313. Reinstall 33rd St. fare boxes at 28th St.—total.	11,500	9,000	5,900
314. Reinstall 28th St. fare boxes at 33rd St.—total.	6,800	9,500	6,000
315. Furnish, rearrange 28th St. telephones—total.	9,000	7,100	800.00
316. Remove, store, 33rd St. telephone equipt.—total	1,000	2,000	800.00
317. Reequip 33rd St. Sta. telephones, etc.—total.	6,200	17,500	14,000
318. Remove 28th St. telephone equipt.—total.	1,600	2,000	850.00
319. Rearrange, furnish, temp. signal oper.—total.	438,800	260,000	215,000
320. Remove, store, 33rd St. signal equip.—total.	39,615	23,000	6,500
321. Reequip 33rd St. signal oper.—total	262,298	285,000	235,000
322. Remove, store surplus signal equip.—total.	11,300	12,000	10,000